VERA EFFIGIES
IOHANNIS MAYNE
Philo: Accomp:

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Arithmetick:

VULGAR,
DECIMAL, &
ALGEBRAICAL.

In a a moſt plain and Facile Method for Common Capacities.

TOGETHER

With a Treatiſe of Simple and Compound Intereſt and Rebate; with two Tables for the Calculation of the Value of Leaſes and Annuities, Payable Quarterly; the one for Simple, the other for Compound Intereſt, at 6. *per Cent. per Annum*; with Rules for making the like for any other Rate.

To which is added

A New, and moſt Practical way of

GAUGING of TUNNS.

AS ALSO

The ART of Cask-Gauging, for the Uſe of His MAJESTIES Officers of the EXCISE.

LONDON,

Printed for *J. A.* and are to be Sold by moſt Book Sellers. 1675.

BRITISH MUSEUM

To his Honoured Friend

THO. WILLIAMS,

M. D.

Physician in Ordinary to His S. Majesty.

SIR,

THough the *happiness* which I formerly enjoyed in your *Converse*, hath been, to *my* great loss, for some years discontinued; yet I easily perswade my self, that the Favour of a *Great Prince*, and the *Best Master* in the World, has not wrought such a change upon your *even Virtue*, but that you will still descend to *remember* him whom you were once pleased to honour with the Name of *Friend*. This Confidence has emboldned me to present you with this *small*

trifle; too *mean* indeed and *trivial* for your acceptance, but that I know you are wont to admit of any thing that proceeds from an *honeſt undeſigning* Gratitude. And though I am not at all inclin'd to *vanity* from the *merits* of the Work it ſelf, yet I am proud that it affords me an opportunity to diſcover the *laſting impreſſions*, which your many *Favours* have made upon my Breaſt. **Geometry**, with **Arithmetick** her Woman, are Beauties, that having Truth written in their Foreheads, dare appear in the Court of the greateſt Monarch, and I doubt not but they will find very eaſie and courteous admittance into your *Appartment*; where if they ſhall afford you any divertiſement when you return wearied from your *ingenious Elaboratory*, I ſhall then accompt that I have written to *very good purpoſe*. However, they certainly aſſure you, that it is *impoſſible* the teeth of Time ſhould obliterate the *honourable eſteem* conſerved for you, in the heart of,

Sir,

Your moſt humble Servant,

JOHN MAYNE.

THE PREFACE.

I Shall not trouble thee, Reader, nor my ſelf, with a long Apology for the publiſhing this Treatiſe. How demurely ſoever I ſhould pretend to the contrary, I fear thou wilt ſtill be apt to imagin, that I had a tolerable good opinion of it, before I ventur'd it to the Preſs; and truly I my ſelf cann't well conceive, how any man ſhould be over ambitious of being publickly laught at. If it be in any meaſure ſuited to the General Good, (for which I intended it,) I may at leaſt expect thy pardon; but if upon the peruſal thou ſhalt find it otherwiſe, I ingenuouſly acknowledge my ſelf to have been miſtaken. My Deſign in this Work is, to render the Rules of thoſe excellent Arts, which the Title-page pretends to, ſo plain and obvious, as that they may be eaſily apprehended without the Aſſiſtance of a living Maſter. And if there were nothing new in the whole, but the perſpicuity of the Principles, and eaſineſs of the Method (which out of civility to my ſelf I muſt deny) yet thoſe alone are ſufficient to vindicate me in this Publication; and I hope thou wilt not be angry, that I am a Well-wiſher to thy Underſtanding. For when I conſider'd, that among the many good Books of this Nature, that are abroad in the

World (though written by Persons of greater knowledge than I dare pretend to) some were so learned and obscure, as not to be understood, unless by those who have already made a considerable proficiency in these things; others, so voluminous and prolix, that they fright the endeavours of such who cannot spend their whole time this way: I was willing, according to my abilities, to obviate both these inconveniences, and accordingly applied my self to the composure of something, which for its plainness and brevity might be accommodated to those of mean Capacities and small Leisure; and this Book is the result of those Contemplations. Whether I have accomplish'd my purpose or no, I make thee the Judge; requiring only that thou censure impartially of the Author and his Endeavours, without being offended that he is desirous to do thee a courtesie. I shall not here expatiate in the praise of the Arguments I treat of, nor give thee one line of Encomium: though out of the great affection I bear to these Arts, I find a strange inclination in my self to be rhetorical, yet I am resolv'd not to affront thee; for truly their usefulness and excellency is so universally known, that to tell thee of it as a new thing, were to suppose thee a Person of more than ordinary ignorance; only (as I said before) I must be so civil to my self too, as to inform thee, that (besides the Introduction *to* Arithmetick *and the* Treatise *of* Interest, *of which I challenge no more than thou shalt find thy self very willing to give me) that Part which concerns the mea-*

suring

ſuring of Solids, viz. *the* Priſmoid, Cylindroid, &c. *is wholly new, and never before made publick. The bulk is bigger than at firſt by me intended; but to gratifie the Book-ſeller, the* Vulgar Arithmetick *was an Appendix, though previous to the reſt. But if one, or other, or all, prove either profitable or pleaſant to thee, I am ſufficiently oblig'd to ſubſcribe,*

From my Houſe at the *Golden-Ball* in *Shaws-Court*, near St. *Georges* Church, *Southwark*; *July* 29. 1673.

Thy Friend,

John Mayne.

To the Ingenious Author, concerning his DECIMALS.

SIr, by your Art, and *Pythagorean* Pen,
I'd prove a *Metempſychoſis* agen;
And were His Soul of *Decimals* but made,
As *Plato*'s Soul o'th' world of *Seven* is ſaid,
I'd ſwear 'twas ſlunk to you; but that you ſhew
More Skill than e're his rambling fancy knew.
Let roving *Rabbies* praiſe their *Seven* and *Four*;
We'l ſhew them *Miſteries* enough and more:
The Heav'nly Orbs are *Ten*, their Motions all
Conſpire to make a perfect *Decimal:*
This is their *Muſick*, and they ſhall be thus,
In ſpight of *Tycho* or *Copernicus.*
'Tis ſaid the *Muſes* are but Nine, but who
(Rather than fail) cann't add *Apollo* too?
Thus may we range the world, and quickly find,
We all to th' number of our Fingers bind.
Thus *Logick* all the wandring *Species* brings,
And places under *tenfold* Heads of *things.*
Thus I, to give the *Author* praiſe in all,
Reduce my *Verſes* to a *Decimal.*

On

On his GAUGING.

YOur *Circles*, Sir, would make my ſolly gheſs,
You were a *Conjurer*, though you wo'n't confeſs.
And *Gauging* is the rugged dev'liſh Name
Of ſome *Hobgobling Imp*, the very ſame
That brought in *Cuſtome*; but what e're he be,
He's a rare Fellow at the *Rule of Three:*
He doth juſt *ſquare* the *Circle*; nay ſo true,
That the *King's Right* is given to a *Cue.*
There's none elſe ſuch *Impoſſibles* can do:
You give the *King*'s, I give this *Right* to you.

J. W.

On his worthy Friend Mr. J. Mayne, *the Author of this* BOOK.

*I*ngenious Artiſt, whither do'ſt aſpire?
*O*r why t'outvye the Ancients do'ſt deſire?
*H*ave they not left enough to following Ages?
*N*o: Thou their Maſter art, they but thy Pages.

*M*y feeble *Muſe* can never ſoar ſo high,
*A*s thy Deſerts herein extend, nor nigh.
*Y*et give me leave hereof to ſpeak my mind:
*N*o Man could better teach us in this kind,
*E*ach Part ſo uſeful, and ſo plain I find.

T. W. Φιλομαθ.

To

To his ingenious Friend the Author
Mr. John Mayne.

WHo reads thy Book with an impartial Eye,
Will ſee how plain, and how ingeniouſly
Thy *Rules* are fram'd; here every Child may learn
Arithmetick, which doth the *Truth* diſcern.
The *Judges* of our Realm could not diſpence
To all Men *Juſtice*, were't not fetch'd from hence:
Thoſe *Sons* of *Mars* that furrow *Neptune*'s Brow,
Unto this *Science* muſt their *Labours* bow:
The *wealthy Merchant*, and *all Traders*, hence
Muſt calculate their *Gain*, or their *Expence*:
The *greedy Miſer*, here may plainly ſee
His *Pelf*'s increaſe at *Compound Uſurie*:
The *Purchaſer* of *Farms*, may alſo here,
Value his *Lordſhips*, whether cheap or deer.
Thy *Squares* and *Cubes*, methinks, ſo *plain* do ſeem,
That I old *Euclid* ſhould thy Father deem.
All *Humane Arts*, Mechanical and Free,
For this *Companion* are oblig'd to Thee.
By *Lines* and *Numbers*, we our Buildings bring
In due proportion, framing every thing.
By *theſe* our *Wooden Walls* and *Towers* are fram'd,
Which *guard* our Iſland, and the Seas *command*:

Theſe

These *fill our Stores* with rich and costly things,
Born from both *Indies* under Canvas Wings:
These *fortifie* our Towns with Forts, by Line;
By these we learn our Foes to *undermine:*
By these th' *Excise* and *Customs* we do scan,
Without *Injustice* to the Trading Man.
Thanks to our *Author* then, that hath set forth
These *Arts* so *plain*, and of *abundant* worth:
Which do to Sea and Land such *Profit* yield,
In Court, in City, Garrison, and Field.

Hugh Handy, Philomath.

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ARITH-

ARITHMETICK
IN
Whole Numbers.

NOTATION.

IT is necessary, that all Persons that would acquaint themselves with the Nature and Use of Numbers, do first learn to know the Characters by which any Quantity is expressed.

These Characters are in number nine, who with a Cypher are the Foundation of the whole Art of Arithmetick. Their form and denomination as in this Example.

0.	1.	2.	3.	4.	5.	6.	7.	8.	9.
Cypher.	One.	Two.	Three.	Four.	Five.	Six.	Seven.	Eight.	Nine.

Theſe Characters ſtanding alone expreſs no more than their ſimple value, as 1 is but one, 2 ſtanding by it ſelf ſignifies but two, and ſo of the reſt; but when you ſee more than one of thoſe Figures ſtand together, they have then another ſignification, and are valued according to the place they ſtand in, being dignified above their ſimple quality, according to the Examples in this Table.

Hundred Millions.	Ten Millions.	Millions.	Hundred Thouſands.	Ten Thouſands.	Thouſands.	Hundreds.	Tens.	Unites.
							1	1
						1	2	2
					1	2	3	3
				1	2	3	4	4
			1	2	3	4	5	5
		1	2	3	4	5	6	6
	1	2	3	4	5	6	7	7
1	2	3	4	5	6	7	8	8
1	2	3	4	5	6	7	8	9

The denomination of Places according to this Table, muſt be well known, and are thus expreſt; thoſe ſtanding in the place of Unites, ſignifie no more than their value before taught; but ſtanding in the ſecond place toward the left hand, they are increaſed to ten times the value they had before, 1 or One in the Unite place ſignifies but One; if it ſtand in the ſecond place toward the left hand, and a Cypher before

fore it thus 10, it hath ten times its ſimple value, and is called Ten; if 2 ſtand in the place of the Cypher thus 12, it is then Twelve, being Ten and two Unites; 1, 2, or 3, ſtanding in third place, with Figures or Cyphers toward the right hand of it, doth ſignifie Hundreds, as 100 is One hundred, 123 is One hundred twenty three, 321 is Three hundred twenty one, 213 is Two hundred thirteen; and ſo any three of the other Figures have like value, according to their Stations, the firſt to the right hand in the Unite place ſignifies ſo many Unites, the ſecond, or that in the place of Tens, is increaſed to ten times its ſimple value, and in the third place, or place of Hundreds, any Figure there ſtanding hath a hundred times the value it would have had were it in the Unite place.

The fourth place is the place of Thouſands, any Figures ſtanding there, with three Figures or Cyphers to the right hand of it, is ſo many Thouſands as ſimply it contains Unites, ſo 3000 is Three thouſand, 9825 is Nine thouſand eight hundred twenty five, *&c.*

The fifth place is Ten thouſands, and any five Figures placed together, are to be read after this manner: *Example.*

45326 Forty five thouſand three hundred twenty ſix.

12345 Twelve thouſand three hundred forty five.

The ſixt place hath the denomination of

Hundred thouſands, and thoſe ſix in the Table that ſtand in a rank are to be read, One hundred twenty three thouſand four hundred fifty ſix.

The ſeventh is the place of Millions, and the ſeven in the Table are, One million two hundred thirty four thouſand five hundred ſixty ſeven.

And the eighth Rank of Figures are to be read, Twelve millions three hundred forty five thouſand ſix hundred ſeventy eight.

The ninth rank is, One hundred twenty three millions four hundred fifty ſix thouſand ſeven hundred eighty nine. And ſo any greater number of places, every figure one place more toward the left hand, is increaſed ten times in value more than in the place it ſtood before.

ADDITION.

Addition, is a gathering or collecting of ſeveral Numbers or Quantities into one Sum, by placing all Numbers of like Denomination under one another, carrying all above ten to the next place, as in theſe Examples.

		245	358
5	56	386	876
6	83	194	988
11	139	825	2222

There

There is likewiſe another kind of *Addition*, that is not of whole Quantities, wherein is neceſſary to be known the number of Parts the Integer or whole Number is divided into, as Pounds and Shillings, every Pound is divided into 20 Shillings, and one Shilling is divided into twelve Pence, one Penny into four Farthings.

Now being to add a Number of Pounds and Shillings together, they are thus ſet down with a ſmall Line or Point between them.

3 - 5 6 : 16

If theſe be added together, obſerve in caſting up your Shillings, ſo many times as you have 20 in the Shillings, you muſt carry Unites to the Pounds, and ſet down the Remainder, being under 20, as in theſe Examples.

l.	*s.*
3	5
6	16
10	01

l.	*s.*
4	17
3	15
3	9
6	12
19	13

In the firſt Example, I find in adding the Shillings together, they make 21, ſo I ſet down 1 and carry 1 Pound to the Pounds: In the ſecond Example, I find among the Shillings 53, which is 2 Pounds 13 Shillings, ſo I ſet down 13 under the Shillings, and 2 to the Pounds.

Any number of Shillings and Pence being to be added together, if your number of Pence amount to above 12, carry 1 to the Shillings, and ſet down the remainder under the Pence; if they make above 24, carry 2 Shillings, and ſet down the remainder, as before.

Examples.

		s. d.
		1 : 7
	s. d.	2 : 6
s. d.	8 : 9	3 : 9
1 : 6	2 : 8	4 : 8
2 : 7	3 : 10	5 : 11
4 : 1	15 : 03	18 : 05

In the firſt Example, you carry one Shilling; in the ſecond, two; and in the third, three.

In Addition of Pence and Farthings, carry ſo many times four as you find in the number of Farthings to the Pence, ſetting down the remainder under the Farthings, as in theſe Examples.

		d. q
		1 : 3
	d. q	2 : 2
	2 : 3	1 : 1
d. q	1 : 2	2 : 3
2 : 3	3 : 1	1 : 3
3 : 2	1 : 3	1 : 2
6 : 1	9 : 1	11 : 2

When

When you would know the Sum of any number of Pounds, Shillings, Pence, and Farthing, they are to be placed thus:

l.	*s.*	*d.*
3	15	10
4	12	09
8	08	07

l.	*s.*	*d.*	*q*
15	10	06	2
19	04	10	3
25	17	09	1
60	13	02	2

Addition of Weight and Meaſure is performed after the ſame manner.

16 Ounces *Averdupois*, make a Pound.
28 Pounds, make a Quarter.
112 Pound, or 4 Quarters, make an Hundred groſs.
20 Hundred, make a Tun.

Examples.

C.	*qs.*	lb.	*os.*
19	3	7	6
15	2	9	15
7	1	18	10
42	0	08	15

C.	*qs.*	lb.	*os.*
9	2	24	15
8	3	14	10
6	3	27	13
7	1	21	14
33	3	05	04

Where obſerve, that ſo oft as I find 16 Ounces, I carry 1 to the Pounds; ſo often as I find 28 Pounds, I carry 1 to the Quarters; and as many times as I find 4 in the Quarters, ſo many times 1 do I carry to the Hundreds.

SUBTRACTION.

Subtraction is the taking a leſſer Number from a greater, and exhibits the Remainder.

In *Subtraction* the Numbers are placed one under another, as in *Addition*, thus:

16
12

The firſt of theſe Numbers is called the *Minorand*, the ſecond the *Subducend*, and the third Number, or the Number ſought, is the *Reſiduum*.

8 *The Minorand.*
6 *The Subducend.*

2 *The Reſiduum or Remainder.*

EXAMPLES of COINS.

	l.	*s.*	*d.*		*l.*	*s*	*d.*
Minorand	8	16	08		45	19	08
Subducend	5	10	07		32	15	06
Reſiduum	3	06	01		13	04	02

But when the number of Pence or Shillings, are greater than the number that ſtands over it in

in the *Minor and*, you muſt borrow the next Denomination, as in this Example.

l.	*s.*	*d.*
127	01	03
116	19	09
10	01	06

This Example I work after this manner, ſaying 9 *d.* out of 3 *d.* I cannot have, wherefore I borrow 1 *s.* from the Shillings, and ſubduct the 9 *d.* from that, and there will remain 3 *d.* which added to the other 3 *d.* maketh 6 *d.* I place therefore 6 *d.* in the Place of Pence, and proceed ſaying, 1 *s.* that I borrowed and 19 is 20 from 1 I cannot, wherefore I borrow 1 *l.* from the Pounds, and ſubduct from that the 20 *s.* and there remains nothing but the 1 *s.* which I place under the Shillings, and ſay, 1 that I borrowed and 6 is 7 from 7 and there remains nothing, then I place a Cypher under the 6, and ſay, 1 from 2 and there remains 1, which I ſet down, and 1 from 1 and there reſteth nothing. After this manner is performed *Subduction of Weight and Meaſure.*

Examples.

C.	*qs.*	lb.
27	3	15
16	2	10
11	1	05

C.	*qs.*	lb.
25	1	7
19	2	12
5	2	23

	C.	*qs.*	*lb.*	*oz.*
	14	1	25	07
	8	3	27	13
	5	1	25	10
Proof	14	1	25	07

By which Examples, the Learner may perceive, that where the number to be ſubducted is greater than the number ſtanding over it, I then borrow one from the next greater denomination, adding the remainder, if any be, to the leſſer number before-mentioned, and ſetting them underneath thoſe of like denomination with them.

The Proof of *Subtraction* is by adding the *Subducend* and *Remainder* together, and their Aggregate muſt always be equal to the *Minorand*, as you may ſee by the laſt Example.

I could here add many more Examples of Weight and Meaſure, but to the ingenious Practitioner I hope it will be enough, all other being wrought after the ſame manner, reſpect being had to the number of leſſer denominations contained in each greater. As

In Troy Weight,

24 Grains make a Penny-weight.
20 Penny-weight one Ounce.
12 Ounces one Pound.

Long

Long Meaſure.

4 Nails make a Quarter of a Yard.
4 Quarters one Yard.
5 Nails one Quarter of an Ell.
4 Quarters one Ell.

12 Inches a Foot.
3 Feet a Yard.
16½ a Perch.
40 Perches a Furlong.
8 Furlongs make an *Engliſh* Mile.

Liquid Meaſure.

8 Pints make a Gallon.
63 Gallons make a Graves Hogſhead.
4 Hogſheads make a Tun.
36 Gallons make a Beer Barrel.
32 Gallons make an Ale Barrel.

Dry Meaſure.

8 Gallons of Corn make a Buſhel.
8 Buſhels make a Quarter.

MULTIPLICATION.

Multiplication is a kind of *Addition*, and reſolveth Queſtions to be performed by *Addition* in a different manner: In order whereunto, it is neceſſary the Learner do well acquaint himſelf with this Table; the having this Table perfectly by heart, will make both this Rule and *Diviſion* alſo very facile, otherwiſe they will be both troubleſome and unpleaſant.

1	2	3	4	5	6	7	8	9	10	11	12
2	4	6	8	10	12	14	16	18	20	22	24
3	6	9	12	15	18	21	24	27	30	33	36
4	8	12	16	20	24	28	32	36	40	44	48
5	10	15	20	25	30	35	40	45	50	55	60
6	12	18	24	30	36	42	48	54	60	66	72
7	14	21	28	35	42	49	56	63	70	77	84
8	16	24	32	40	48	56	64	72	80	88	96
9	18	27	36	45	54	63	72	81	90	99	108
10	20	30	40	50	60	70	80	90	100	110	120
11	22	33	44	55	66	77	88	99	110	121	132
12	24	36	48	60	72	84	96	108	120	132	144

In the firſt Rank of this Table, you have an Arithmetical Progreſſion from 1 to 12, and

and alſo in the firſt Column toward the left hand downwards. This Table doth at firſt ſight exhibit the Sum of any number, ſo often repeated as you ſhall require, provided the numbers do neither of them exceed 12.

Multiplication hath three Members, thus called, a *Multiplicand*, a *Multiplicator*, and a *Product*: The *Multiplicand*, is the number to be repeated; the *Multiplicator*, is the number of times the firſt is to be repeated; and the *Product*, is the Sum of the *Multiplicand* ſo often repeated. As for *Example*.

A Countrey-man ſold 6 Buſhels of Wheat for 5 s. how many Shillings ought he to receive?

By *Addition* 6 muſt be 5 times ſet down thus:

6
6
6
6
6
30

Or 5 ſix times repeated thus:

5
5
5
5
5
30

But by *Multiplication* it is done thus:

6 *The Multiplicand.*
5 *The Multiplicator.*

Now

Now if you look in the Table precedent, in the firſt Column find 5, then look in the firſt Rank for 6, and caſt your Eye down to their Angle of meeting, and you will find 30 ſtanding under 6 and againſt 5, I then conclude that 5 times 6 is 30; that is called the *Product*, and they will ſtand thus:

6 *The Multiplicand.*
5 *The Multiplicator.*

30 *The Product.*

But when you have a number to multiply, greater than any in the Table, as for *Example:*

A Gentleman having forborn his Rent of a Farm, at 157 l. per *Quarter, for* 3 *Quarters, what ought he to receive?*

The *Multiplication* will ſtand thus:

157 *The Multiplicand.*
3 *The Multiplicator.*

471 *The Product.*

I then ſay, 3 times 7 is 21, I ſet down 1 and carry 2; then, 3 times 5 is 15 and 2 is 17, I ſet down 7 next the 1, and carry 1; ſaying, 3 times 1 is 3 and 1 is 4, as in the Example before-going; and the Product is 471 *l.*

There

There is yet more variety, of which take these Examples following.

If 65 Ships do carry 536 Men in every Ship, how many Men will there be in all?

536 *The Multiplicand.*
65 *The Multiplicator.*

2680
3216

34840 *The Product.*

I say 5 times 6 is 30, set down 0 and carry 3; then 5 times 3 is 15 and 3 is 18, set down 8 and carry 1; then 5 times 5 is 25 and 1 is 26, which I set down: Then for the next Figure, I say, 6 times 6 is 36, I set down 6 one place short of the former rank, and carry 3; then 6 times 3 is 18 and 3 is 21, set down 1 and carry 2; again, 6 times 5 is 30 and 2 is 32, these I set down: Then draw a line, and cast them up as they are placed, and the Sum is the *Product* and Answer to the Question, *viz.* 34840 Men.

In *Multiplication*, always make the lesser Number the *Multiplicator*, for it is all one whether I multiply 5 by 15, or 15 by 5, the Product is always the same.

If

If 128 *Men of War have each made* 746 *Shot, how many Shot were made in all?*

```
 746
 128
------
5968
1492
 746
------
95488
```

Begin as before with the Unites place, and say, 8 times 6 is 48, set down 8 and carry 4; 8 times 4 is 32 and 4 is 36, set down 6 and carry 3; then 8 times 7 is 56 and 3 is 59, which set down: Then go forward with the 2, (but remember to place your remainder one Figure short of the former) saying, 2 times 6 is 12, set down 2 under the 6 and carry 1; 3 times 4 is 8 and 1 is 9, which set down; twice 7 is 14, which set down: Also then, once 6 is 6, which place under the 9; once 4 is 4, which set under the 4; and once 7 is 7, which set under the 1: Then cast them up, as in *Addition*, and the Sum is the *Product*, and answers the Question, *viz.* 95488 Shot.

If any number be to be multiplied by 1 with Cyphers, it is but adding so many Cyphers to the *Multiplicand* as there is in the *Multiplicator*.

As for Example.

If 35678 be to be multiplied by 10, add one Cypher to the *Multiplicand*, thus, 356780; if by 100, add two Cyphers, thus, 3567800; *&c.*

And

And when any number is to be multiplied by any other number, that hath Cyphers annexed, always place the Cyphers immediately under the Line, as in these Examples.

568	1678	8546
20	3500	81000
11360	13390000	8546000
	8034	68368
	9373000	692226000

DIVISION.

Division is also a kind of *Subduction*, and informs the Querent, how many times one number is contained in another.

There is in *Division* these three things to be observed, *viz.* the *Dividend*, the *Divisor*, and the *Quotient*. The *Dividend* is a number to be divided into parts, the *Divisor* is the quantity of one of those parts which the former is to be divided by, the *Quotient* is the number of such parts as the *Dividend* doth contain. There is also by accident a fourth number in this Rule necessary to be known, which is a *Number*, and that happens when the *Dividend* doth not contain an equal number of such parts as it is divided by, as when 15 is to

be divided by 4, the *Dividend* is 15, the *Divisor* is 4, and there is a *Remainder* 3.

In *Division* you may place your numbers thus.

Dividend.

Divisor 4) 15 (3 *Quotient.*

3 *Remainder.*

Multiplication is positive, but *Division* is performed by essays or tryals, after this manner:

35)14665(4
140
6

Here I first inquire how many times 3 I can have in 14, I find 4 times, I place 4 in the *Quotient*, and then multiply the *Divisor* by that 4, placing the Product underneath the *Dividend*, as in the Example, say, 4 times 5 is 20, set down a Cypher under the 6 and carry 2, then 4 times 3 is 12 and 2 is 14, which I set down also, as in the Example, then subduct this Product from the Figures standing over them, and set down the Remainder.

35)14665 (41
140
66
35
31

Then for a new *Dividend*, I bring down the next figure, and postpone that to the Remainder, and inquire how many times 3 in 6, I cannot have twice, because I cannot

cannot have twice 5 from 5, I say then once, and place 1 in the *Quotient*, proceeding as before saying, once 5 is 5, which I place under the first 6 toward the right hand, and once 3 is 3, which I set down under the other 6; subducting these as the former, I find the Remainder to be 31.

After which I bring down the next figure in the *Dividend*, and postpone it to the Remainder, as in this Example: Then I inquire how many times 3 in 31, I suppose 9 times, placing 9 in the *Quotient* I multiply again, saying 9 times 5 is 45, 5 and carry 4; then 9 times 3 is 27, and 4 is 31; these being set down, as before directed, and subducted, there will remain nothing. I then conclude, that the *Divisor* is so often contained in the *Dividend* as is expressed in the *Quotient*, *viz.* 419 times.

```
35)14665(419
   140
   ---
    66
    35
   ---
   315
   315
   ---
   000
```

For further Instructions, take these Examples.

```
286)6884(24
    572
    ---
    1164
    1144
    ----
      20
```

```
304)9436(31
    912
    ---
     316
     304
     ---
      12
```

98765) 87654323 (887
790120

864232
790120

741123
691355

49768

REDUCTION.

Reduction is twofold, *viz.* bringing greater denominations into ſmaller, and that by *Multiplication*, as Pounds into Shillings, Shillings into Pence, *&c.* Alſo leſſer denominations are reduced into greater, by *Diviſion*, as Pence into Shillings, Shillings into Pounds, Minutes into Hours, Hours into Days, and Days into Years, *&c.*

Having any number of Pounds to reduce into Pence, multiply them by 240.

Example.

In 869 *Pounds how many Pence?*

240

34760
1738

Anſw. 208560 *Pence.*

In 2486 *Shillings how many Farthings?*

48

19888
9944

Answ. 119328 *Farthings.*

How many Minutes are there in 9476 *Hours?*

60

The Answer 568560 *minutes.*

How many Pounds, Shillings, and Pence, are contained in 22929 *Farthings?*

l. s. d. q

Farthings in 1 *l.* 960) 22929 (23 : 17 : 08 : 1
1920
3729
2880
849
Farthings in 1 *s.* 48) 849 (
48
369
336
33
Farthings in 1 *d.* 4) 33 (
C 3 M

In 544542 Cubique Inches, how many Beer Barrels, Firkins, and Gallons?

Bar. firk. g.

Inches in 1 B. Bar. 10152)544542(53 : 2 : 5
50760

36942
30456

Inches in 1 Firkin 2538)6486
5076

Inches in 1 Gallon 282)1410
1410

0000

THE RULE OF THREE.

THis *Rule* is so called, because herein are three numbers given to find a fourth; of these three numbers, two are always to be multiplied together, and their Product is to be divided by the third, and the Quotient exhibits the fourth number, or the number sought.

And here note, That of the three given numbers, if that number that asketh the Question be greater than that of like denomination with it self, and require more, or if it be less, and require less, then the number of like denomination is the Divisor. Or,

Or, if the number that asketh the Question be less than that of like denomination, and require more; or if it be more, and require less, then the number that asketh the Question is the Divisor.

Example.

If 3 Yards of Sarcenet cost 15 s. what shall 32 Yards cost?

Which 3 numbers if you please may stand thus:

3 . 15 :: 32

15

160

32

3) 480 (160

3

180

Here you may see the term that asketh the Question is greater than that of like denomination, being 3, and the other 32, and also requires more, *viz.* a greater number of Shillings; therefore, according to the Rule, the first term, or the term of like denomination to that which asketh the Question, is the Divisor.

And the Answer is 160 Shillings; which being divided by 20 will be found 8 l.

Again,

If 32 Ells of Holland cost 160 s. what shall 3 Ells cost?

32 . 160 :: 3

3

32)480(15

32

160

160

0

In this Question (being the Converse of the former) you may see the term that asketh the Question, here 3, is lesser than that of like denomination, being 32 Ells, and also requires less; therefore the first term here also is the Divisor.

And the Answer is 15 s.

If 36 Mending a Trench in 12 Hours, in how many Hours will 144 Mending the same?

In this Question, the term that asketh the Question is greater than that of like denomination, and requires less; wherefore the term that asketh the Question is the Divisor.

If 144 Workmen build a Wall in 3 Days, in how many Days will 36 Workmen build the same?

144 . 3 :: 36

3

36)432(12 Days.

36

72

72

This Question you may perceive to be the Converse of the former, here the term that asketh the Question is less than that of like denomination, and requires more, the term that asketh therefore is the Divisor.

If 125 lb. of Biskey be sufficient for the Ships Company for 5 Days, how much will Victual the Ship for the whole Voyage, being 153 Days?

This Question is of the same kind with the first Example; here the two terms of like denomination

nomination are 5 Days and 153 Days, the term that asketh the Question being more than the term of like denomination, and also requiring more; so, according to the general Rule, the term of like denomination to that which asketh the Question is the Divisor. It matters not therefore in what order they are placed, so you find your true Divisor; but if you will you may set them down thus:

125 . 5 :: 153

125

765

306

153

5) 19125 (3825

15

41

40

12

10

25

00

The Answer is 3825 lb. weight of Bisket.

A Ship having Provision for 96 Men during the Voyage, being accompted for 90 Days, but the Master taking on board 12 Passengers, how many Days Provision more ought he to have?

Which is no more than this:

If 96 Men eat a certain quantity of Provision in 90 Days, in how many Days will 108 Men eat the same quantity?

96 . 90 :: 108

96

540

810

108) 8640 (80

864

0000

The Answer is 80, so that for 108 Men he ought to have 10 Days Provision more.

If the Assize of Bread be 12 Ounces, Corn being at 8 s. the Bushel, what ought it to weigh when it is sold for 6 s. the Bushel?

8 . 12

8 : 12 :: 6
8
6)96(16
6
36
36

In this Queſtion, the term inquiring being leſs than the term of like denomination, and requiring more; therefore is the term ſo inquiring the Diviſor.

The Anſwer is 16 Ounces.

THE RULE OF PRACTICE.

IT is neceſſary that the Learner get theſe two Tables perfectly by heart, which are only the aliquot parts of a Pound and of a Shilling.

The Parts of a Shilling.

d.	*q.*	
0	1	Forty eighth.
0	2	Twenty Fourth.
0	3	Sixteenth.
1	0	Twelfth.
1	2	Eighth.
2	0	Sixth.
3	0	Fourth.
4	0	Third.
6	0	Half.

The

The Parts of a Pound.

s.	d.	q.	
0	00	1	The Nine hundred and ſixtieth.
0	00	2	The Four hundred and eightieth.
0	00	3	The Three hundred & twentieth.
0	01	0	The Two hundred and Fortieth.
0	01	2	The Hundred and ſixtieth.
0	02	0	The Hundred and twentieth.
0	03	0	The Eightieth.
0	04	0	The Sixtieth.
0	05	0	The Forty eighth.
0	06	0	The Fortieth.
0	08	0	The Thirtieth.
0	10	0	The Four and twentieth.
1	00	0	The Twentieth.
1	03	0	The Sixteenth.
1	04	0	The Fifteenth.
1	08	0	The Twelfth.
2	00	0	The Tenth.
2	06	0	The Eighth.
3	04	0	The Sixth.
4	00	0	The Fifth.
5	00	0	The Fourth.
6	08	0	The Third.
10	00	0	The Half.

Having theſe Tables perfectly in memory, any Queſtion propounded will be readily reſolved, only by dividing the given number of

Yards,

Yards, Ells, Feet, Inches, Gallons, Quarts, Pounds, or Ounces.

Of which take some Examples.

145 *Ells of Cloth at* 3 *d. per Ell.*
36 *s.* 3 *d.*

Three Pence being the fourth part of a Shilling, I divide the number by 4, and the quote is the number of Shillings it is worth.

728 *at* 4 *d.*
242 *s.* 8 *d.*

Four Pence being the third part of a Shilling, I divide by 3.

654 *at* 6 *d.*
327 *s.*

Here take the half.

321 *at* 1 *d.* 2 *q.*
40 *s.* 1 *d.* 2 *q.*

Here the eighth part.

542 *at* 2 *d.* 1 *q.*
90 : 4 : 0
11 : 3 : 2
101 *s.* 7 *d.* 2 *q.*

Here take the sixth and the eighth part of the quote.

Having any number of Shillings to reduce into Pounds, cut off the last figure toward the right

right hand by a line, and the figures on the left hand of the line are so many Angels as they expres Unites; draw a line under them, and take the half of them, and you have the number of Pounds.

Examples.

l.	*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*
3	6	03	24	2	08	32	7
1	16	08	12	02	08	16	07

l.	*s.*	*d.*	*q*	*l.*	*s.*	*d.*	*q*
4	0	01	2	10	1	07	2
2	00	01	2	5	01	07	2

Any Commodity, the value of 1 Yard being the aliquot part of a Pound, is thus cast up:

836 *Yards of Broad Cloth at* 6 *s.* 8 *d. per Yard.*

278 *l.* 13 *s.* 4 *d.*

Take the one third part, and that is the Answer in Pounds: 3 in 8 twice, and carry 2; 3 in 23 seven times, and carry 2; 3 in 26 eight times, and carry 2; the third part of 2 *l.* is 13 *s.* 4 *d.* where always observe, that the Remainder is always of the same denomination with the Dividend.

654 lb. of Cloves at 5 s. per lb.
163 l. 10 s.

Take the fourth part.

9464 Gall. of Brandy at 3 s. 4 d.
1577 l. 6 s. 8 d.

The Sixth.

Where the Price is not aliquot.

625 at 3 s. per Ounce.
62 : 10 s.
31 : 05
93 : 15

Here I take the tenth and the half of that tenth.

348 Dollers at 4 s. 6 d.
69 l. 12 s.
8 : 14
78 : 06

The fifth and the eighth of that fifth.

245 lb. at 2 s. 3 d.
24 : 10
3 : 01 : 03
27 : 11 : 03

The tenth and the eighth of that quote.

To cast up the amount of any Commodity, sold for any number of Farthings by the Pound,

I borrow from the *Dutch* a Coin called a Guilder, whose value is 2 *s. English.*

Then if a Question be proposed of the Amount of an Hundred weight of any Commodity, by the Hundred Gross, *viz.* 112 lb. so many Hundred as there be, the Amount is so many Guilders so many Groats, as there are Farthings in the price of 1 lb.

As for Example.

A Hundred weight of Iron is sold for 5 Farthings the Pound, comes to 5 Guilders, that is 10 *s.* and 5 Groats, which together is 11 *s.* 8 *d.*

Again.

A Hundred weight of Lead is sold for 2 *d.* Farthing the Pound, that is 9 Guilders and 9 Groats, which is 21 Shillings.

But if it be the subtil Hundred, it is then but so many Guilders so many Pence: As if a Hundred weight of Tobacco be sold for 5 *d.* Farthing the Pound, the Hundred comes to twenty one Guilders and twenty one Pence, that is forty three Shillings and nine Pence.

ARITHMETICK IN DECIMALS.

NOTATION.

Integers.									Decimals.								
9	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	9
Thousand Millions.	Hundred Millions.	Ten Millions.	Millions.	Hundred Thousands.	Ten Thousands.	Thousands.	Hundreds.	Tens.	Unites.	Tenths.	Hundredths.	Thousandths.	Ten Thousandths.	Hundred Thousandths.	Millionths.	Ten Millionths.	Hundred Millionths.	Thousand Millionths.

AS in Whole Numbers, the value or denomination of Places do increase by Tens, from the Unite place toward the left hand; so in Decimals, the value or denomination of Places do decrease by

by Tens, from the Unite-place toward the right hand, according to the precedent Table.

A Fraction or broken Number is always less than a Unite, as Pence are parts of a Shilling, and Shillings of a Pound, Inches of a Foot, and Minutes of an Hour, &c.

Fractions are of two kinds,

And are thus called { *Vulgar*, & *Decimal*.

A *vulgar* Fraction is commonly expressed by two Numbers set over one another, with a small line between them, after this manner $\frac{2}{3}$, the uppermost being called the Numerator, and the lower the Denominator.

The Denominator expresseth into how many parts the Integer or whole Number is divided, and the Numerator sheweth how many of those parts is contained in the Fraction.

Example.

If the Integer be a Shilling $\frac{2}{3}$ is 8 *d.*
If it be 1 *l.* or 20 Shillings, it is 13 *s.* 4 *d.*
If a Foot, it is then 8 Inches.
Or if an Hour, it will be 40 Minutes.

A *decimal* Fraction hath always a common Number for a Numerator, and a *decimal* Number for its Denominator.

A *decimal* Number is known by Unity, with

one or more Cyphers ſtanding before it, as 10, 100, 1000, *&c.*

A *decimal* Fraction is known from a whole Number by a point, or ſome other ſmall mark of diſtinction, whether it ſtand alone, or be joyn'd with whole Numbers; as in theſe following Examples.

·3275	3·275	32·75	327·5
15653	51653	56153	56513

Or elſe with a point over the head of Unity, or the Unite place; as in theſe Examples.

03275	3275	3275	3275

In *decimal* Fractions, the Numerators only are ſet down, the Denominator being known by the laſt Figure in the Numerator.

Example.

·2 is Two tenths.
·25 is Twenty five Hundredths.
·257 is Thouſandths.
·2575 is Ten Thouſandths, *&c.*

As Cyphers before a whole Number have no value, ſo Cyphers after a *decimal* Fraction are of no ſignification: But Cyphers before a *decimal* Fraction, are of ſpecial regard; for

as Cyphers after a whole Number do increase that Number, so before a *decimal* Fraction they diminish the value of that Fraction.

Example.

.25 Twenty five hundredths.
.025 Twenty five thousandths.
.0025 Twenty five ten thousandths.

Each Cypher so added removing the Fraction further from Unity, making it ten times less than before.

ADDITION.

Addition in Decimals, whether in pure Decimals, or whole Numbers mixt with Decimals, differs not from *Addition* in whole Numbers, only care must be had to the seperating lines or points, that all places of like denomination stand one under another, both in the Addends and in the Sum; as in these Examples.

.359	.206	55.675
.432	.032	2.031
.352	.103	.889
.816	.005	3.025
1.959	.346	60.740

SUBTRACTION.

AS in *Addition*, so in *Subtraction* care must be had to the placing each Figure under that of like denomination with it self, then it is the same with *Subtraction* in whole Numbers.

Examples.

.875	5.43	28
.368	.215	1.565
.507	5.215	26.435

A

243	3
.257	.09375
242.743	34.89625

MULTIPLICATION.

Multiplication in whole Numbers serveth instead of many *Additions*, and teacheth of two Numbers given to increase the greater as often as there are Unites in the lesser.

It likewise consists of three Requisites, *viz.* a *Multiplicand*, a *Multiplicator*, and a *Product*.

The

The *Multiplicand* is the Number to be increased.

The *Multiplicator* is the Number by which it is to be increased.

And the *Product* is the Sum of the first Number so often repeated as there are Unites in the second.

In decimal Fractions, or whole Numbers mixt with Fractions, the two first Numbers are called *Factors*, and the last is called the *Fact*.

Multiplication, whether in decimal Fractions, or whole Numbers mixt with Fractions, differeth not (in the Operation) from *Multiplication* in whole Numbers: The last Figures in both the *Factors* may be placed under one another, without respect to the distinction of places, or places of like denomination standing under one another, as in *Addition* and *Subduction*; yet from the *Product* must be cut off by a line or point so many places as there are Figures in decimal Fractions in both *Factors* of the last Figures standing towards the right hand.

Examples.

.25	.459	6.25	25
3	3.6	.5	8.5
.75	2754	3.125	125
	1377		200
	1.6524		212.5

If it happen when the *Multiplication* is ended, that there be fewer Figures in the *Product* than there are places in Decimals in both the *Factors*, then put Cyphers before the *Product* till the number of places be equal to those in both the *Factors*: As in these

Examples.

.0275	.06	.3	.25
.02	.4	.2	.003
.000550	.024	.06	.00075

Whereby may be observed, That the *Multiplication* of two Fractions doth not increase them as in whole Numbers, but they are thereby made less, and the *Fact* is removed further from Unity than either of the *Factors*.

If a whole Number be to be multiplied by a decimal Number, put so many Cyphers after the whole Number as there are in the decimal Number, and that Number will be the *Product*. If 48 be multiplied by 10, it will be 480; by 100, 4800; *&c.*

In multiplying decimal Fractions, or mixt Numbers, by a decimal Number, you need only remove the point or seperating line so many places toward the right hand as there be Cyphers in the decimal Number. If you multiply .2845 by 10, the *Fact* will be 2.845; by 100, it will be 28.45; by 1000, 284.5; *&c.*

DIVI-

DIVISION.

Diviſion, both in whole Numbers and Fractions, is by young Practitioners found to be more difficult than any of the four Species; it will therefore require a little more induſtry in the Learner: But when once had, there will appear ſmall difference between the Operation herein, as in any the precedent.

Diviſion is alſo conſtituted by three Requiſites, and a fourth by accident, *viz.* a *Dividend*, a *Diviſor*, and a *Quotient*: The fourth is a *Remainder*, which doth not always happen to be.

The *Dividend* is the Number to be divided.

The *Diviſor* is the Number by which the other is to be divided.

The *Quotient* is the Number found out by the Diviſion.

And the *Remainder* is that which is left of the Dividend after the Diviſion is ended, and is always leſs than the Diviſor.

Example.

If 12 be to be divided by 4, then is 12 the Dividend, 4 the Diviſor, and the Quotient will be 3.

If 13 be divided by 3, then 13 is the Dividend, 3 the Diviſor, 4 the Quotient, and there will be a Remain, which is here 1. De-

Decimal Fractions, or mixt Numbers, are divided after the same manner as whole Numbers are divided, only care must be had in giving a true value to the Quotient. To perform which, observe well this General Rule.

The first Figure in the Quotient is always of the same denomination with that Figure which stands (or is supposed to stand) over the Unity place in the Divisor.

As to the manner of placing your Figures, and the way of dividing, there are many published by divers Writers of *Arithmetick*: The way of placing the Divisor under the Dividend, is the most apt for giving a value to the Quotient; but the raising of Figures, and repeating the Divisor so often, is found an inconvenience; which to avoid, observe the following Examples.

Being to divide 2487.048 by 53.6, I place them in this order;

53.6) 2487.048 (

Then I consider if the Divisor were placed under the Dividend, the Unity place in the Divisor, here 3 would stand under the 8 in the Dividend, I then set a mark over the head of the 8, and conclude the first Figure in the Quotient to be of the same denomination with it, which is Tens, in whole Numbers.

53.6

53.6) 2487.048 (4
343

Having thus found the value of the first Figure in the Quotient, I proceed to the division, and inquire, how many times 5 in 24? I find 4; I then set 4 in the Quotient, and go back, multiplying the whole Divisor by that Figure, and subduct the Product out of the Dividend, placing the Remainder underneath as part of a new Dividend: Thus 4 times 6 is 24, from 27, and there remains 3, which I place under the 7; again, 4 times 3 is 12, and 2 that I borrowed is 14, from 18, and there remains 4, which I place under the 8, as in the Example; then 4 times 5 is 20, and 1 I borrowed is 21, from 24, and there remains 3, which I place under the 4. For my new Dividend, I bring down the next Figure, here a Cypher, and postpone it to the Remainder, and the Example will stand thus:

53.6) 2487.048 (46
343 0

Then proceeding in my Division, I ask, how many times 5 in 34? finding 6 times, I then place 6 in the Quotient, and as before say, 6 times 6 is 36, from 40, and there remains 4, which I set down under the Cypher; then 6 times 3 is 18, and 4 I borrowed is 22, from 23, and

and there remains 1, which I place under the 3; then 6 times 5 is 30, and 2 I borrowed is 32, from 34, and there will remain 2, which I place under the 4; then to this Remainder I bring down the next Figure in the Dividend, postponing it as I did the Cypher, and they will stand thus:

53·6) 2487·948 (46·4
343
2144

I now inquire, how many times 5 in 21? and find 4 times. I then place 4 in the Quotient, and go on as before; there being yet a Remainder, I add a Cypher, and proceed as before; and find, upon the adding one Cypher, my Divisor greater than the Dividend, I place a Cypher in the Quotient. Example

53·6) 2487·948 (46·401
343 0
2144
800

Having placed a Cypher in the Quotient, I add another to the Dividend, and make it 800; and then inquire, how many times 5 in 8? finding once, I put 1 in the Quotient, working as before: Where note, So long as there is a Remainder, if you add Cyphers and work after this manner, you may have as many Decimals as you please. It

It doth often happen in Division, in decimal Fractions, or mixt Numbers, that the Unite place in the Divisor will stand beyond all the significant Figures in the Dividend, either toward the right hand or toward the left; in which case, that you may the better find out the value of the first Figure in your Quotient (according to the precedent General Rule) add Cyphers to the right or to the left hand of the Dividend, till you come over the Unity place in the Divisor, and what value or denomination that place is of, that is the denomination of the first Figure in the quote; as in these

Examples.

254)21.00(.0826
680
1720
196

24)7.2(.3
0

3.42)2681(783.9
2870
1340
3140
62

254)21:00(.08
2032
680

.4275) 0351 (13763
760
2100
1750
1000
175

42.75) 354.375 (8.375
16 375
3 1000
14250
1575

.025) 0.225 (9
00

.08375) 025.750 (307.4
62500
38750

.002) 001.6 (500

If in Division in whole Numbers, there happen to be a Remainder, it is the Numerator of a Common Fraction, and the Divisor is the Denominator, and this Fraction is part of the quotient.

Example.

If you divide 66 by 8, the quotient will be 8 and $\frac{2}{8}$, according to the way of Vulgar Fractions,

Fractions, but in Decimal Fractions it will be 8.25.

Common way.	*Decimal way.*
8)66(8 2/8	8)66(8.25
2	20
	40
	0

If you be to divide a whole by a decimal Number, cut off ſo many places by a mark, as there are Cyphers in the decimal Number: If 468 be divided by 10, the quote is 46.8; by 100, 4.68; and by 1000, quotes .468.

If a decimal Fraction, or a mixt Number, be to be divided by a decimal Number, remove your line or point ſo many places toward the left hand, as there are Cyphers in your decimal Number, ſupplying the vacant places with Cyphers, if there be occaſion: 69.5 divided by 10, is 6.95; by 100, it will be .695; by 1000, .0695; and by 10000, quotes .00695; *&c.*

Diviſion being the Converſe of *Multiplication*, as multiplying a mixt Number or decimal Fraction by a decimal Number, you remove your mark of diſtinction toward the right hand; ſo in dividing a decimal Fraction or mixt Number by a decimal Number, the mark is removed toward the left hand, as in the foregoing Examples.

RE.

REDUCTION.

TO reduce a vulgar Fraction into a decimal Fraction, your Rule is: *Divide your Numerator by your Denominator, and the Quotient will be a decimal Fraction of the same value with the vulgar Fraction.* So $\frac{1}{4}$, if reduced into a decimal Fraction, will be .25.

Example.

4)1.0(.25
20
—
0

Here note, That only the even parts of an Integer will be exactly reduced into a decimal Fraction, as $\frac{1}{2}$, $\frac{1}{8}$, $\frac{1}{16}$, *&c.* In all Surds, there will be some Remainder, but if you carry your decimal Fraction to four or five places, making the last one more than it is, if the sixth Figure be above 5, or else leave them out, and your Calculation will come near the truth; but if any desire to be more exact, he may take as many as he please.

Ex.

Examples.

$\frac{1}{3}$ 3)1.0(.33333 $\frac{2}{3}$ 3)2.0(.66666

10 20

10 20

10 20

10 20

10 20

1 2

$\frac{1}{7}$ 7(3.0(.428571 $\frac{2}{9}$ 9)2.0(.2222

20 20

60 20

40 20

50 20

10

30

To reduce any decimal Fraction out of a greater denomination into a leſſer, multiply the Fraction by thoſe parts of the Integer into which you would have it reduced; as .65 being the parts of a Pound, you would know how many Shillings are contained in the Fraction, multiply it by 20: If you deſire the Pence therein contained, multiply it by 240; or if Farthings, multiply by 960, the number of Farthings in a Pound or 20 Shillings.

.65		.65	
20		240	
13.00		2600	
Anſw. 13 *s.*		1300	
		156.00	*Anſw.* 156 *d.*
	.65		
	960		
	3900		
	985		
	624.00	*Anſw.* 624 *q.*	

The decimal parts of a Foot are reduced, by multiplying them by 12; if parts of a Foot Square, by 144; and the decimal parts of a Foot Solid, by 1728, the Cubick Inches in a Foot of Solid. The decimal parts of a Pound, are reduced by 16, the Ounces in a Pound *Averdupois*; and 12, the Ounces in a Pound *Troy*. The decimal parts of a Beer Barrel by 36, and by 32 reduceth the parts of an Ale Barrel, into Gallons; and Gallons into Pints, by 8; Gallons into Cubick Inches, by 282; and for Wine Gallons, by 231, the number of Cubick Inches in ſuch a Gallon, *&c.*

As greater denommations are reduced to leſſer, by a multiplication of the ſeveral parts of the Integer; ſo leſſer denominations are reduced

reduced to greater, by diviſion. Any number of Shillings are reduced into Pounds, and the decimal parts of a Pound, if you divide them by 20; and Pence, if divided by 240.

Example.

s.	d.
20)15.0(.75	240)180.0(.75

Hours are reduced into the decimal parts of a Day, if you divide them by 24, the Hours in a Day Natural; and Minutes into the parts of an Hour, if divided by 60.

Perches are reduced into the decimal parts of an Acre, if you divide them by 160, the number of Square Poles or Perches in an Acre; and any number of Feet into Poles, and the decimal parts of a Pole, if you divide them by 16.5 the Feet in a Pole, or by 158.25 the number of Square Feet in a Square Pole; but if Wood-land Meaſure by 18, or if a Square Pole by 324, the Square Feet in a Pole or Perch of ſuch Meaſure.

Any number of Inches are reduced into the parts of a Beer Barrel, if divided by 10152; and into Ale Barrels and parts, by 9024; *&c.*

For the eaſe of the Reader here is made a Table of *Engliſh* Coin reduced into the decimal parts of a Pound *ſterling*.

A Table of Reduction of Englisb Coin, the Integer being one Pound.

Shillings.	*Decimals.*	*Pence.*	*Decimals of a Pound.*
19	.95	11	.0458333
18	.9	10	.0416667
17	.85	9	.0375
16	.8	8	.0333333
15	.75	7	.0291667
14	.7	6	.025
13	.65	5	.0208333
12	.6	4	.0166667
11	.55	3	.0125
10	.5	2	.0083333
9	.45	1	.0041667
8	.4		
7	.35		
6	.3		
5	.25	*Farthings.*	*Decimals of a Pound.*
4	.2		
3	.15	3	.003125
2	.1	2	.0020833
1	.05	1	.0010417

The Uſe of the Table.

Having any Queſt. wherein Pounds, Shillings & Pence, are required to be under one denomination, *viz.* Pounds, and the parts of a Pound: Firſt ſeek in the Column of Shillings for your Shillings, and ſet down the Fraction that ſtands againſt it; then in the Column of Pence, ſeek your Pence; in the Farthings, your Farthings; add all theſe together, and the Sum is the decimal Fraction deſired.

Example.

What is the decimal Fraction for 17 *s.* 9 *d.* $\frac{3}{4}$ *?*

Firſt as the decimal parts of a Pound ſeek for 17 *s.* and the Fraction againſt it in the other Column is .85;

Which ſet down thus ——	.85
Then againſt 9 *d.* I find ——	.0375
And againſt 3 Farthings —	.003125
Their Sum is ——	.890625

Which is the Number required, and is the decimal Fraction for 17 *s.* 9 *d.* $\frac{3}{4}$, as parts of a Pound.

Again, having a decimal Fraction in the parts of a Pound, and its deſired to know the value thereof in leſſer denominations: Let it be the Fraction before found, *viz.* .890625: I ſeek in the Table of Fractions for the neereſt to it,

and find .85, and againſt it 17 *s.* I then ſet .85 down, and ſubduct it from the other, and there remains .040625; I look over the Table again, and find the next neereſt is .0375, againſt it 9 *d.* I ſubduct that; and find the Remainder .003125, ſtand againſt 3 Farthings.

.890625
.85

.040625
.0375

.003125

So finding the value of any other decimal Fraction: If any thing remain after the laſt ſubduction, being leſs than a Farthing, I caſt it away as of ſmall regard.

THE GOLDEN RULE.

THis Rule is called the *Rule of Three*, becauſe herein are three Numbers given, to find a fourth. It is alſo called the *Rule of Proportion*, for as the firſt is in proportion to the ſecond, ſo is the third to the fourth: And the Converſe.

This Rule is called the *Golden Rule* for its excellent uſe in the Solution of Queſtions of various kinds, and great advantage is made of it in almoſt all kind of Calculations Arithmetical.

Two

Two of the three Numbers given in every Rule of Proportion are of one denomination, and the third is of the ſame kind with the fourth ſought; and one of the two Numbers that are of like *ſpecies* doth always ask the Queſtion.

Arithmeticians diſtinguiſh this Rule by two denominations, one they call the *Direct*, and the other the *Inverſe* or *Backer Rule of Three.*

One of the three given Numbers of like denomination in any Rule of Proportion is a Diviſor, the other remaining two are Multipliers. To find which of the forementioned Numbers is the Diviſor, take theſe following Rules.

1. If that Term to which the Queſtion is annexed be more than that of like denomination, and alſo requires more; or if it be leſs, and require leſs than the Term of like denomination; then that Term of like denomination to that which asketh the Queſtion is the Diviſor, and the Queſtion is in the *Direct Rule of Three.*
2. If the Term which asketh the Queſtion be more than that of like *ſpecies*, and requires leſs; or leſs, and requires more; then that Term which asketh the Queſtion is the Diviſor, and the Queſtion is in the *Backer* or *Inverſe Rule of Three.*

Having by the precedent Rules diſcovered the Diviſor, multiply the other two Numbers, and

divide by the Diviſor, your quote will be the Anſwer to the Queſtion.

Note, If any of the Numbers given be in ſeveral denominations, they muſt be reduced into one, either greater or leſſer, as before directed.

Example.

Queſt. 1. *If* 12 ½ *Yards of Taffaty coſt* 5 *l.* 7 *s.* 9 *d.* 3 *q. what ſhall* 5 ½ *Yards coſt?*

In this Example, of the three Numbers given there are two of like denomination, and they are 12 ½ and 5 ½, the latter of which is the Term which asketh the Queſtion, known always by the words *what* or *how much*. And this Term is leſs than that of like kind with it ſelf, and alſo requires leſs, therefore according to the precedent Rule, this Queſtion is in the *Golden Rule Direct*. Theſe three Numbers may be placed in what order you pleaſe, provided you miſtake not your Diviſor, but according to the general way, being reduced into Decimals, and of one *ſpecies*, they will ſtand thus:

Yards.	*l.*	*Yards.*
12.5	5.390625	:: 5.5

Then, as before directed, multiply the ſecond and third Numbers, and divide by the firſt, and the quotient exhibits the fourth Proportional or the Number ſought. 12.5

12.5 . 5.390625 :: 5.5
5.5

26953125
26953125

12.5) 29.6484375 (2.371875
464
898
234
1093
937
625

00

The Answer is 2 *l.* 7 *s.* 5 *d.* 1 *q.*

Queſt. 2. *If* 6 *Yards of Broad Cloth coſt* 4 *l. what ſhall* 32 *Yards coſt?*

Here the Term which asketh the Queſtion is greater than the Term of like denomination, and requires more; therefore the Term of like denomination to the Term that asketh the Queſtion is the Diviſor.

6 . 4 :: 32
4

128

6)128(21.333
20
20
20
2

The Answer is 21 *l.* 6 *s.* 8 *d.*

Queſt. 3. *If* 320 *Men raiſe a Breaſt-work in* 6 *Hours, in what time will* 750 *Men do the ſame?*

Here the Term that asketh the Queſtion is more than the Term of like denomination, and requires leſs; therefore the Term that asketh the Queſtion is the Diviſor, and this is the *Backer Rule of Three.*

320 . 6 : : 750
6

750)1920(2.56
4200
4500
00

The Answer is 2 *Hours,* 33 *Minutes, and* 36 *Seconds.*

Queſt.

Queſt. 4. *If* 756 *Men dig a Trench in* 12 *Hours, in how many Hours will* 126 *dig the ſame?*

Here the Term that asketh the queſtion is leſs than the Term of like denomination, and requires more; then according to the Rule the Term demanding is the Diviſor, and this queſtion is alſo in the *Inverſe Rule of Three.*

756 . 12 :: 126
12

126) 9072 (72
252

00

The Anſwer is 72 *Hours.*

There is ſometimes four Numbers given in a queſtion, yet is it but a *Single Rule of Three*, for one of the four Numbers is of no ſignification, and might as well have been left out.

Example.

Queſt. 5. *If* 10 *Workmen build a Wall* 40 *Foot long in* 3 *Days, in what time might* 50 *Men have done the ſame?*

Here note, there is four numbers given, and yet there is but three to be uſed in working the

the queſtion, you muſt therefore find which thoſe 3 are that are neceſſarily to be uſed: Thus,

Firſt, you muſt take the Term that asketh the queſtion, here 50 Workmen; ſecondly, you muſt have the Term of like denomination with it, which is 10 Workmen; thirdly, the Term ſought, being Days; you muſt take the Term of like denomination with that alſo, which is here 3 Days: The ſuperfluous Term then in the queſtion is 40, which might have been left out, and they will then ſtand thus:

10 . 3 :: 50

3

50) 30.0 (.5

The Anſwer is Half a Day or 12 *Hours.*

This queſtion is in the *Rule of Three Inverſe.*

Queſt. 6. *If* 100 *l. gain* 6 *l. in* 12 *Months, what ſhall* 32 *l. gain in the ſame time?*

In this queſtion the 12 Months is the ſuperfluous Term, being of no uſe in the Calculation, the Terms required being 100 *l.* 6 *l.* and 32 *l.*

Note, Though the Terms in this queſtion be all Money, and ſo may ſeem to be of one *ſpecies*, yet they are not; 100 *l.* and 32 *l.* are

are of one kind, being both Principal, and the other Term is of the ſame denomination with the Term ſought, *viz.* Gain or Intereſt.

100 . 6 :: 32
6

100) 192 (1.92

The Anſwer is 1 *l.* 18 *s.* 4 *d.* 3 *q. fere.*

And this queſtion is in the *Direct Rule of Three*, the Term that asked the queſtion being leſs than the Term of like denomination, and alſo requiring leſs, *&c.*

THE DOUBLE GOLDEN RULE.

THis Rule is called the *Double Golden Rule*, or *Double Rule of Three*, becauſe it requires two diſtinct Calculations, before you can anſwer the queſtion.

And in this Rule there are five Numbers given to find a ſixth ſought.

This differs not in the operation from the *Single Rule*, only the Calculation is twice repeated.

Of the five Numbers given, the queſtion is ſometimes annexed to two, and ſometimes but to one.

If

If the queſtion be annexed to two of the five given Numbers; then are there two of the other three of the ſame *ſpecies* with thoſe that ask the queſtion, and the third is proportional to the Number ſought.

For the due regulation of theſe two Calculations, when the queſtion is annexed to two of the five Numbers, take theſe Directions.

Firſt, take one of the Numbers demanding, and let that ask the queſtion in the firſt operation; ſecondly, take that of the ſame *ſpecies*, and alſo that of the like quality with the reſpondent, of theſe three conſtitute your firſt Rule of Proportion; then find which is your Diviſor, according to your Rule *pag.* 55. and proceed to find the fourth in proportion.

Then for your ſecond *Rule of Three*, take the other of the two Numbers to which the queſtion is annexed, and let that ask the queſtion; take alſo the Number of like kind, and the fourth Number found in the firſt Calculation; judge which is your Diviſor, and work accordingly; the laſt Quotient will be the ſixth Number, or the Number ſought.

Example.

If a Trench be 20 *Perches in length, and made by* 12 *Men in* 18 *Days; how long may that Trench be, that ſhall be wrought by* 48 *Men in* 72 *Days?*

Here

Here the queſtion is annexed to two of the five Numbers, *viz.* 48 Men and 72 Days; now according to the foregoing direction, take one of the two Numbers inquiring, 48, and ſay,

Men. Poles.

As 12 . 20 :: 48

20

12) 960 (80 *the fourth Number ſought.*

Then take the other of the two Numbers inquiring, and ſay,

Days. Poles.

As 18 . 80 :: 72

80

18) 5760 (320 *the ſixt Number, and anſwer of the queſtion.*

36

00

If 6 Lighters bring 60 Tuns of Ballaſt in 5 Tides, how many Tun will 15 bring in 12?

6 . 60 :: 15 . 150

5 . 150 :: 12 . 360 *the ſixth Number ſought.*

If

If a Man travel 160 Miles in 4 Days, when the Days are 10 Hours long; in how many Days will he travel 195 Miles, when the Days are 14 Hours long?

160 : 4 :: 195

4

160) 780 (4.875 *the 4th number.*
1400
1200
800
0

10 : 4.875 : 14

10

14) 48.75 (3.482 *the sixt number, and answer to the question, viz.* 3 *Days*, 11 *Hours*, 34 *Minutes*, ferè.
6
115
30
20
60
4

When a Question is stated in the *Double Rule of Three*, so that there is but one Number inquiring,

First, take that Number, and let it ask the question in the first Rule; take also the Number of

of like denomination, together with the Number joyn'd to that of like denomination; and of theſe three Numbers conſtitute your firſt Rule of Proportion.

Secondly, let that Number which was found in the firſt Operation, ask the queſtion in the ſecond; then take the Number of like denomination to it, and alſo the Number joyn'd with that like Number; of theſe three is your ſecond compounded; find your Diviſor, and proceed; the laſt quote exhibits the Anſwer.

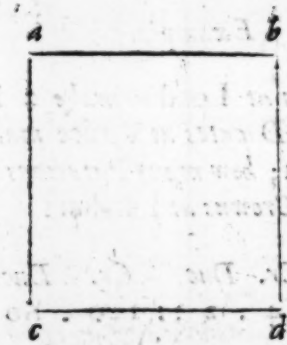
Example.

If 4 *Crowns at* London *make* 2 *Ducates at* Venice, *and* 8 *Ducates at* Venice *make* 20 *Patacoons at* Genoa; *how many Patacoons at* Genoa *will make* 120 *Crowns at* London?

	Cr.	*Duc.*	*Cr.*	*Duc.*
First	4	2 ::	120	60
	Duc.	*Pat.*	*Duc.*	*Pat.*
Second	8	20 ::	60	150

Of the Square Root.

A Square is a plain Superficies bounded with four right Lines of equal length, the Angles alſo are equal, being all right Angles, as *(a b c d)*



The meaſure of a Square is by a Square, that is, when it is known how many Square Inches, Feet or Perches, is contain'd in any Superficies, the Content or Area of the ſaid Superficies is then ſaid to be known. And in a Square, it is found by multiplying the length by the breadth, which being equal, it is called *Squaring of a Number*, and by the Learned Dr. *Pell*, *Involution*, and the Product or Area is the ſecond Power; now the Side of ſuch

ſuch a Square is by *Geometricians* called a *Root* or the *firſt Power.*

Let the Side a b *be* 222 *Inches, Feet, or Perches,* &c.

222

444
444
444

49284 *the Area or q. Number.*

Now having the Area of a Square or Square Number given, and the Side or Root be required.

This is called the *Extraction of a Square Root*, and alſo *Evolution of the ſecond Power.*

Let the Number be as before 349284.

The firſt thing to be done in the Extraction of a Root is punctation, or pointing the Number given; which is thus done, firſt ſet a point over the Unite-place, and omitting one point every other Figure thus, 349284; there being three points in the Number, intimates three figures in the Root.

To proceed then, enquire the greateſt Square Number contained in thoſe figures, under the firſt point on the left hand; the greateſt Square Number in 34 is 25, whoſe Root is 5, which place in the quotient for the firſt figure in the Root, ſubduct its Square out of 34, and ſet the Remainder 9 underneath as in the Example.

Example.

349284 (5
25

9

The first figure in the Root thus found, the rest are found by Division; for a Dividend bring down the figures under the next point, and postpone them to the last Remainder, and the Example will stand thus, your Divisor being double the Root found.

349284 (59
25
---
10) 992
981

11

Then I proceed to Division, always supposing the last Figure in my Divisor standing under the last save one in the Dividend; the Number to be subducted from the Dividend must always be the Square of the last Figure in the Root, and the Divisor multiplied by the last Figure in the Root, so added together as in this Example, *viz.* so that the Unite-place in the last Number stand one place further to the right hand.

Nine times the Divisor ——— 90
And 9 multiplied by it self —— 81

981

Which

Which being subducted from the Dividend will remain 11, as part of a new Dividend, to them bring down the two next figures, and the Example will stand thus:

```
      349284(59
      25
      ----
  10) 992
      981
      ----
 118) 1184
```

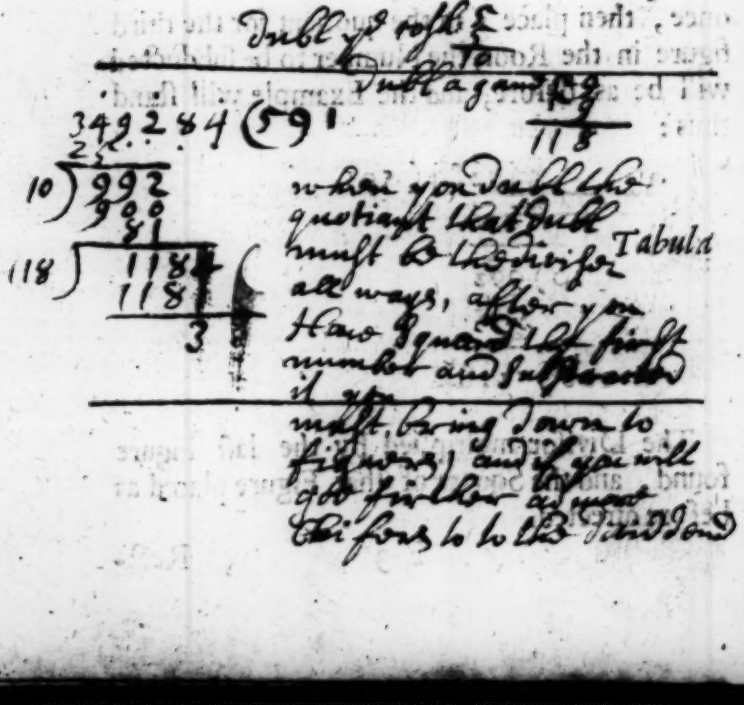
The Divisor as before is double the whole Root found, and for the Number to be subducted, after you have made enquiry how many times the Divisor will be found in the Dividend, if so placed as aforesaid, it will here be found once, then place 1 in the quotient for the third figure in the Root, the Number to be subducted will be as before, and the Example will stand thus:

```
      349284(591
      25
      ----
  10) 992
      981
      ----
 118) 1184
```

The Divisor multiplied by the last Figure found, and the Square of that Figure placed as before directed.

Rectangle	118
Square	1
	1181
1181 *ſubducted from the Dividend*	1184
There will remain but	3

Which ſheweth the Number was not a Square Number; but if you deſire to have it further, add two Cyphers to the Remainder for a new Dividend, double your whole quotient for a new Diviſor, and you may have as many Decimals as you pleaſe.



Tabula Laterum Quadratorum ab Unitate ad 200.

Quadrata.	*Latera.*
1	1,00000,000000
2	1,41421,356237
3	1,73205,080757
4	2,00000,000000
5	2,23606,797750
6	2,44948,974278
7	2,64575,131106
8	2,82842,712474
9	3,00000,000000
10	3,16227,766017
11	3,31662,479036
12	3,46410,161514
13	3,60555,127546
14	3,74165,738677
15	3,87298,334621
16	4,00000,000000
17	4,12310,562562
18	4,24264,068712

Quadrata.	Latera.
19	4,35889,894354
20	4,47213,595500
21	4,58257,569496
22	4,69041,575982
23	4,79583,152331
24	4,89897,948556
25	5,00000,000000
26	5,09901,951359
27	5,19615,242271
28	5,29150,262213
29	5,38516,480713
30	5,47722,557505
31	5,56776,436283
32	5,65685,424948
33	5,74456,264654
34	5,83095,189485
35	5,91607,978310
36	6,00000,000000
37	6,08276,253030
38	6,16441,400297
39	6,24499,799840
40	6,32455,532034
41	6,40312,423743
42	6,48074,069841

Quadrata.	Latera.
43	6,55743,852430
44	6,63324,958071
45	6,70820,393250
46	6,78232,998313
47	6,85565,460040
48	6,92820,323028
49	7,00000,000000
50	7,07106,781185
51	7,14142,842854
52	7,21110,255093
53	7,28010,988928
54	7,34846,922835
55	7,41619,848710
56	7,48331,477355
57	7,54983,443527
58	7,61577,310586
59	7,68114,574787
60	7,74596,669241
61	7,81024,967591
62	7,87400,787401
63	7,93725,393319
64	8,00000,000000
65	8,06225,774830
66	8,12403,840464

Quadrata.	Latera.
67	8,18535,277187
68	8,24621,125124
69	8,30662,386292
70	8,36660,026534
71	8,42614,977318
72	8,48528,137424
73	8,54400,374532
74	8,60232,526704
75	8,66025,403784
76	8,71779,788708
77	8,77496,438739
78	8,83176,086633
79	8,88819,441732
80	8,94427,191000
81	9,00000,000000
82	9,05538,513814
83	9,11043,357914
84	9,16515,138991
85	9,21954,445729
86	9,27361,849550
87	9,32737,905309
88	9,38083,151965
89	9,43398,113206
90	9,48683,298050

Quadrata.	Latera.
91	9,53939,201417
92	9,59166,304863
93	9,64365,076099
94	9,69535,971483
95	9,74679,434481
96	9,79795,897113
97	9,84885,780180
98	9,89949,493661
99	9,94987,437107
100	10,00000,000000
101	10,04987,562112
102	10,09950,493836
103	10,14889,156509
104	10,19803,902719
105	10,24695,076596
106	10,29563,014099
107	10,34408,043279
108	10,39230,484541
109	10,44030,650891
110	10,48808,848170
111	10,53565,375285
112	10,58300,524426
113	10,63014,581273
114	10,67707,825203

Quadrata.	Latera.
115	10,72380,529476
116	10,77032,961427
117	10,81665,382639
118	10,86278,049120
119	10,90871,211464
120	10,95445,115010
121	11,00000,000000
122	11,04536,101719
123	11,09053,650641
124	11,13552,872566
125	11,18033,988750
126	11,22497,216032
127	11,26942,766958
128	11,31370,849898
129	11,35781,669160
130	11,40175,425099
131	11,44552,314226
132	11,48912,529308
133	11,53256,259467
134	11,57583,690279
135	11,61895,003862
136	11,66190,378969
137	11,70469,991072
138	11,74734,012447

Quadrata.	*Latera.*
139	11,78982,612255
140	11,83215,956000
141	11,87434,208704
142	11,91637,528781
143	11,95826,074310
144	12,00000,000000
145	12,04159,457879
146	12,08304,597359
147	12,12435,565298
148	12,16552,506060
149	12,20655,561573
150	12,24744,871392
151	12,28820,572744
152	12,32882,800594
153	12,36931,687685
154	12,40967,364599
155	12,44989,959799
156	12,48999,599680
157	12,52996,408614
158	12,56980,508998
159	12,60952,021292
160	12,64911,064067
161	12,68857,754045
162	12,72792,206136

Quadrata.	Latera.
163	12,76714,533480
164	12,80624,847487
165	12,84523,257867
166	12,88409,872673
167	12,92284,798332
168	12,96148,139682
169	13,00000,000000
170	13,03840,481041
171	13,07669,683062
172	13,11487,704860
173	13,15294,643797
174	13,19090,595827
175	13,22875,655532
176	13,26649,916142
177	13,30413,469565
178	13,34166,406413
179	13,37908,816026
180	13,41640,786500
181	13,45362,404707
182	13,49073,756323
183	13,52774,925847
184	13,56465,996625
185	13,60147,050874
186	13,63818,169699

Quadrata.	*Latera.*
187	13,67479,433118
188	13,71130,920080
189	13,74772,708488
190	13,78404,875209
191	13,82027,496109
192	13,85640,646056
193	13,89244,398945
194	13,92838,827718
195	13,96424,004377
196	14,00000,000000
197	14,03566,884762
198	14,07124,727947
199	14,10673,597967
200	14,14213,562373

The Use of the precedent Table is principally for the ease of the industrious Artist; when he hath the Extraction of a Square Root in the Solution of any Question, it is but seeking the given Number in the Table, and just against it he shall find the Root. By the

ſubſequent Examples will it plainly appear, how uſeful ſuch a Table to 1000 Roots would be in quadratique Equations, and in the Cubes alſo, which (were there incouragement given to the Sons of Art) I doubt not but ſome ingenious Perſon would enrich the World therewith; theſe being long ſince Calculated by Mr. *Henry Briggs* of *Oxford*, and given me by my honoured Friend, Mr. *John Collins*, his deſire being to have them made more publick, and the conveniency of ſuch a Table (before mentioned) ſhewn, by ſome Examples upon this.

Of Quadratique Equations.

Mr. *Dary*, in his *Miſcellanies*, *chap.* 8. ſaith to this, or the like purpoſe:

1. *When any Equation propos'd is incumbred with Vulgar Fractions, let it be reduced to its leaſt Terms in whole Numbers, if poſſible; if not, let it be brought to its leaſt Terms in Decimals.*

2. It is evident from divers Authors, *That if any Quantity ſhall be ſigned* —, *then the Square Root, or the Root of any even Power of ſuch Quantity ſo ſign'd, is inexplicable, for they cannot be generated from any Binomials that ſhall be equal.*

As for Example:

— 9 being a Negative can be made of nothing (if taken as a Square Number) but + 3, and

and -3, which Roots are not equal, they being neither both Affirmatives nor both Negatives.

3. When you have cleared the Equation by the Second hereof, and that the Co-efficient in the higheſt Power is taken away, or be Unity, then will quadratique Equations reſolve themſelves into the four following Compendiums.

4. Let your Equation be ſo reduced, that the higheſt Power ſtand on the left ſide alone, the ſign $+$ being always annexed, or ſuppoſed to be annexed.

Example, Queſita a.

First Equation.

$$+aa = +ba + r$$

$$+\tfrac{1}{2}b + \sqrt{+\tfrac{1}{4}bb + r} = +a$$
$$+\tfrac{1}{2}b - \sqrt{+\tfrac{1}{4}bb + r} = -a$$

$$+\tfrac{1}{4}bb + r$$

Second Equation.

$$+aa = +ba - r$$

$$+\tfrac{1}{2}b + \sqrt{\tfrac{1}{4}bb - r} = +a$$
$$+\tfrac{1}{2}b - \sqrt{\tfrac{1}{4}bb - r} = +a$$

$$+\tfrac{1}{4}bb - r$$

Third Equation.

$$+aa = -ba + r$$

$$-\tfrac{1}{2}b + \sqrt{+\tfrac{1}{4}bb + r} = +a$$
$$-\tfrac{1}{2}b - \sqrt{+\tfrac{1}{4}bb + r} = -a$$

$$+\tfrac{1}{4}bb + r$$

Fourth Equation.

$$+aa = -ba - r$$

$$-\tfrac{1}{2}b + \sqrt{+\tfrac{1}{4}bb - r} = -a$$
$$-\tfrac{1}{2}b - \sqrt{+\tfrac{1}{4}bb - r} = -a$$

$$+\tfrac{1}{4}bb - r$$

Illustration by Numbers, Queſita a.

Firſt Equation.

$$+aa = +6a + 27$$

$$+3 + \sqrt{36} = -a \text{ And } a = +9$$
$$+3 - \sqrt{36} = -a \text{ And } a = -3$$

$$+9$$
$$+27$$
$$36$$

Proof

Proof of the Affirmative.

The Square of $9 = 81$

Six times the Root $= 54$

To which add 27

81

Which was to be proved.

Proof of the Negative.

$+3$	-3
$+3$	$+6$
$+9$	-18
	$+27$
	$+9$

Example 2.

$+aa = +8a + 46$

$+4 + \sqrt{+62} = 7.874$

4

$+11.874 = +a$

$+4 - \sqrt{+62} = 7.874$

$+4$

$+16$	$-3.874 = a$
$+46$	
$+62$	

Second Equation.

Example 1.

$+aa=+18a-17$

$+9+\sqrt{+64}+8$

$+9$

$+17=a$

$+9-\sqrt{+64}+8$

$+9$

$+81$

-17

$+64$

$+1=a$

Example 2.

$+aa=+14a-46$

$+7+\sqrt{+3}=1.73205,080757$

7

$8.732<=a$

$+7-\sqrt{+3}=1.732$

7

$+49$

-46

$+3$

$5.268>=a.$

Third

Third Equation.

Example 1.

$+aa=-12a+108$

$-6+\sqrt{+144}=+12$

-6

$+6=a$

$-6-\sqrt{+144}=-12$

-6

$+36$

$+108$

144

-18

Example 2.

$+aa=-20a+94$

$-10+\sqrt{+194}=+13.92838,827718$

-10

$+3.92838,827718=a$

$-10-\sqrt{+194}=-13.9284>$

-10

100

94

194

$-23.9284>$

Fourth Equation.

Example 1.

$+aa=-10a-9$

$-5+\sqrt{+16}=+4$

-5

$-1=a$

$-5-\sqrt{+16}=-4$

-5

$-9=a$

$+25$

-9

$+16$

Example 2.

$+aa=-16a-36$

$-8+\sqrt{+28}=+5.29150,262213$

-8

$-2.70849,737787$

$=a$

$-8-\sqrt{+28}=-5.2915<$

-8

$+64$

-36

$+28$

$-13.2915< =a$

But

But if in a Square Equation there happen to be a Coefficient annexed to the higheſt Power, it is reſolved by transferring the Coefficient with the Sign of Multiplication to the other ſide.

Admitting the Equation be

$$2aa = +6a + 8$$

Then the Coefficient 2 being transferred (as before directed) they will ſtand as in this Example.

Firſt Equation.

$$2aa = +6a + 8 \times 2$$

$$+3 + \sqrt{25} = +2a$$

$$+3 - \sqrt{25} = -2a$$

$$+9$$

$$+16$$

$$+25$$

The Root of $+25$ being $+5$, then is $+5+3 = 8$, and $a = +4$, the Affirmative Anſwer. And $+3-5$ is $= -2$, and $a = -1$, the Negative Anſwer.

The Proof is eaſie:

Firſt, if a be $= 4$, $2aa$ is $= +32$, and $6a$ is $= +24$, to which $+8$ being added, the Sum is $+32$ which was to be proved.

Again, $a = -1$, then $2aa$ is $= -2$, whereto $+8$ being added, the Sum is $= +6$, which alſo was to be done.

Second Equation.

$$4aa = +26a - 12 \times 4$$

$$+13 + \sqrt{121} = +4a$$
$$+13 - \sqrt{121} = +4a$$

39
13

+169
− 48

121

Now $+13 +$ the $\sqrt{121}$, *viz.* $+11$ is $= +24$, the $\frac{1}{4}$ whereof is $= +6 = a$, and $aa = 36$, and $4aa = +144$, $+26a = +156$, to which if -12 be added, the Sum will be $+144$ alſo.

Again, If to $+13$ you add $-$ the $\sqrt{121}$, *viz.* -11, $4a$ will be $= +2$, and conſequently $+a = +\frac{1}{2}$, $4aa$ is then $= +1$, and $+26 = +13$, to which add -12, and the Sum is $= +1$, which was to be proved.

Third Equation.

$$5aa = -6a + 32 \times 5$$

$$-3 + \sqrt{169} = +5a$$
$$-3 - \sqrt{169} = -5a$$

+9
+160

+169

$-3+13=+5a$, here $a=+2$, $5aa=+20$, $-6a=-12$, to which add $+32$, the Sum is also $+20$.

Again, $-3-13=-16=-5a$, and $a=-3.2$, $5aa=+51.2$: Also $-6a$ being $=+19.2$, to which add $+32$, the Sum is $=+51.2$.

Fourth Equation.

$$2aa=-10a-8\times 2$$

$$-5+\sqrt{9}=-2a$$
$$-5-\sqrt{9}=-2a$$

$$+25$$
$$-16$$
$$+9$$

$-5+3=-2a$, then $a=-1$, $-10a=+10$
-8
$+2$

$2aa=+2$

$-5a-3=-2a$, then is $a=-4$
-10
$+40$
-8
$+32$

$-a=-4$
-4
$+16$
2
$+32$

Which was to be done.

Note,

Note, Always where there is no Sign annexed to any Term in the Equation, the Sign + is ſuppoſed to be annexed.

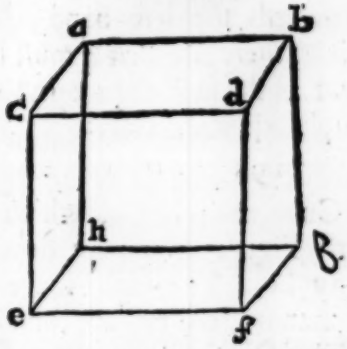
I have been the larger in theſe Examples, that the young *Analiſt* may with the more eaſe apprehend the ſeveral kinds by this variety; in ſome of the ſurd Roots I have on purpoſe omitted the large number of Places, four or five being ſufficient for uſe in moſt caſes; but if any deſire to be more exact, he may take them as far as he pleaſeth, or the Table doth exhibit.

Of

Of the Cube Root.

THe Cube is a Solid, and hath three dimenſions, length, breadth, and depth, and is incloſed by ſix plain ſquare Superficies.

Example.



Let the Side a, b, *or* c, d, &c. *be* 125: *To find the Content in Solid Feet or Inches, is the Involution of the Side or Root.* Thus:

125	15625
125	125
625	78125
250	31250
125	15625
15625	1953125 The Solidity.

And this is called the Third Power. The

The Evolution hereof, is alſo termed the Extraction of the Cube Root, wherein obſerve firſt your punctation, omitting two, point every third Figure.

Example.

$$7\dot{1}95\dot{3}12\dot{5}$$

The firſt Figure in the Root is found by taking the greateſt Cube Number, contained in the Figure or Figures that ſtand under the firſt Point towards the left hand, here 71, whoſe Root is 4, therefore that 4 muſt be placed in the Quotient as the firſt Figure in the Root, and the Example will ſtand thus:

$$7\dot{1}95\dot{3}12\dot{5}\ (4$$

Then the Cube of 4 is 64, which ſubduct out of the firſt Figures, and ſet down the remainder if any be. The firſt Figure found in this peculiar manner, the reſt are found by Diviſion thus: The Dividend conſiſts of the remainder, if any be, and the three Figures under the next Point poſtponed; the Diviſor is always three times the Square of the Root, and three times the Root it ſelf: Theſe two Numbers being ſo to be added together, as that the Unites of the firſt ſtand over the Tens of the ſecond.

Three times the q. of the $\surd = 48$
Three times the $\surd = 12$

Diviſor 492

Then

Then will the Example ſtand thus:

7 1 9 5 3 1 2 5 (4
64

492) 7953

Then proceed to Diviſion, always ſuppoſing the laſt Figure in the Diviſor to ſtand under the laſt ſave one in the Dividend, and enquire, how many times 4 in 7? place 1 in the Quotient. Then for your Number to be ſubducted out of the Dividend, it always conſiſts of three Numbers, *viz.*

Three times the q. of the firſt Figure = 48
Multiplied by the ſecond 1

Product of the firſt by the ſecond 48
3 times the q. of the ſecond by the firſt 12
And the Cube of the ſecond 1

The Subducend 4921

7 1 9 5 3 1 2 5 (41
64

492) 7953 The q. of 41 = 1681
4921 3

3032. q of 41 × 3 = 5043

Then for a new Dividend, bring down the three next Figures, poſtponing them as before.

The Diviſor thrice the q. of the √ 41 = 5043
And three times the √ 41 = 123

50553

Which

Which being set on the left hand the Dividend, stands thus:

```
          7̇1953̇125̇(415
          64
          ----
   492(   7953
          4921
          -----
 50553)   3032125
```

Then enquire, how many times 5 in 30? you will find 5 times, which place in the Quotient. Your Subducend is as before,

3 times the Square of 41 × 5 =	25215
3 times the Square of 5 × 41 =	3075
And the Cube of 5 =	125
The Subducend	2552375
Which being subducted from	3032125
There will remain	479750

Which shews the Number was not a Cube Number; if you add three Cyphers, and work as before, you may have as many Decimals Fractions as you please.

In this Extraction I have not taken the same Number the Cube first mentioned did produce, but by adding another Figure, made the Number greater, that it might take in all Cases; but in the following Extraction it is explicated.

1̇953̇125̇

1953125 (125
1
33) 0953
728
4356) 225125
225125
0

Three times the Square of the Root = 3
Three times the Root is alſo = 3
The firſt Diviſor = 33

Three times the Square of 1 = 3
2
Three times the Square of 1 × 2 = 6
Three times the Square of 2 × 1 = 12
The Cube of 2 = 8
The firſt Subducend = 728

12
12
144
3
Three times the Square of the Root = 432
Three times the Root = 36
The ſecond Diviſor = 4356

Three

Three times the Square of the $\sqrt{12} = 432$
5

Three times the Square of $12 \times 5 = 2160$
Three times the Square of $5 \times 12 = 900$
The Cube of $5 = 125$

The ſecond Subducend $= 225125$

A SHORT TREATISE OF SIMPLE & COMPOUND *INTEREST:* WITH TWO TABLES FOR THE CALCULATION OF The Value of *Leaſes* or *Annuities* by Quarterly Payments, at *6 per Cent. per Annum.*

By *John Mayne.*

London, Printed by *William Godbid*, for *Nath. Crowch*, in *Exchange-Alley*.
M. DC. LXXIII.

A SHORT
TREATISE
OF
SIMPLE & COMPOUND
INTEREST:
WITH
TWO TABLES
FOR
CALCULATION

Of Simple Interest.

QUestions in *Simple Interest* are wrought by the Double Rule of Proportion, wherein five Numbers are given to find the sixt.

And if you put P = 100 Principal, and T for Twelve Months, G = 6 *l.* the Rate of Interest, and *p* = any other Sum greater or lesser, *t* = any other Time (above or under Twelve Months) and also *g* = to the Gain thereof at that Rate.

Then if any one Term of these six be unknown, it is explicated by the other five (like Symbols having the same denomination) as in this Equation.

$$PTg = ptG$$

That is the Fact of 100 *l.* multiplied by one year, and that Product by 6 the Interest of 25 *l.* for 4 years, is equal to the Fact of 25 multiplied by 4 years, and that Product by 6, the Interest of 100 *l.* for one year.

Example.

P = 100	*p* = 25
T = 1	*t* = 4.
100	100
g = 6	G = 6
600	600

Which was to be proved.

Now foraſmuch as the uſual Queſtions of Simple Intereſt, are propoſed from a Sum preſently due to the Gain thereof, *& contra*; it will be requiſite you put A = the Amount of a Sum, forborn or due hereafter, and then you will have A = *p* + *g*, as in the former Equation.

Example.

P T P+G
As 100 in 1 to 106
So 25 in 4 to 31 = *p* + *g*

From the precedent Analogiſm will ariſe theſe four Propoſitions.

Prop. I.

A Sum preſently due = p, *being forborn a certain time* = t, *at a certain rate* = G, per Cent. per Annum: Q. *the Amount* = A?

Equa-

Equation $A = \frac{ptG}{TP} + p.$

That is, the given Sum multiplied by the given Time, and that Product again multiplied by the given Rate of Interest, the last Product divided by the Principal, *viz.* 100, in the Time, *viz.* 1, exhibits the Gain of that Sum in that Time.

Illustration.

Quest. 1. 25 *l.* being forborn 18 Months, at 6 *per Cent. per Annum*, what doth it amount to?

$$\begin{array}{rl} & 25 = p \\ & 1.5 = t \\ \hline & 125 \\ & 25 \\ \hline P = 100 & 37.5 \\ T = 1 & 6 = G \\ \hline PT = 100 & 225.0 \end{array}$$

$$\begin{array}{r} 2.25 \\ 25 = p \\ \hline 27.25 = A \end{array}$$

The Answer being 27 *l.* 5 *s.* the Amount in that time.

Quest. 2. If 175 *l.* be forborn for 7 Years, at 6 *per Cent. per Annum*, Simple Interest, what will it amount to at the end of the said time?

$$175 = p$$
$$7 = t$$
$$1225$$
$$6 = G$$
$$TP = 100 \,)\, 73.50$$
$$175 = p$$

The Answer = 248.5 That is 248 *l.* 10 *s.*

Prop. II.

A Sum of Money = A, *due at a certain time hereafter* = t, *at a certain Rate of Interest* = G, per Cent. per Annum. Q. *The present worth* = p ?

$$\text{Equation, } p = \frac{ATP}{TP + tG}$$

That is, the Fact of the Amount multiplied by the Principal, 100, in the Time, *viz.* 1 Year, divided by the said Principal multiplied into the said Time, more the Rate of Interest multiplied into the Time of Forbearance, the Quotient is equal to the present worth.

Example.

Quest. 1. If 248 *l.* 10 *s.* be due at the end of 7 years, what is it worth in ready money, discompting Interest, at 6 *per Cent. per Annum.*

7 = t

$7 = t$ $\quad$ $248.5 = A$

$6 = G$ $\quad$ $100 = PT$

42 $\quad$ $142)\,24850.0\,(175 = p$

$PT = 100$ $\quad$ 1065

142 $\quad$ 710

00

The Answer is 175 *l.*

Quest. 2. If 950 *l.* be due at the end of 12 years, what is it worth in ready money, at 9 *per Cent. per Annum* Simple Interest?

$12 = t$ $\quad$ $950 = A$

$9 = G$ $\quad$ $100 = PT$

108 $\quad$ $208)\,95000\,(456.7307$

$PT = 100$ $\quad$ 1180

208 $\quad$ 1400

1520

640

1600

144

The Answer is 456 *l.* 14 *s.* 7 *d.* $\frac{1}{4}$ *ferè.*

Prop. III.

A Sum presently due = p, *having been forborn a time unknown* = t, *did amount to a certain Sum* = A, *at a Rate of Interest* = G, per Cent. per Annum. Q. *the Time of forbearance* = t?

Equation, $\frac{A - p : \times TP}{pG} = t.$

That is to say, the Amount less the Principal, so increased, multiplied by 100, and that Product divided by the Fact of the beforementioned Principal, and Rate of Interest, quotes the Time of forbearance.

Example.

Quest. 1. If 175 *l.* hath been forborn till with the Interest at 6 *per Cent. per Annum* it is increased to be 248 *l.* 10 *s.* Q. How long hath it been forborn?

$175 = p$ — $248.5 = A$ —

$6 = G$ $175 = p$

1050 $73.5 = A - p$

$100 = PT.$

1050) 7350.0 ($7 = t$

0000

The Answer is 7 years.

Quest. 2. If 25 *l.* hath been forborn till it is amounted to 27 *l.* 5 *s.* at 6 *per Cent. per Annum*, Simple Interest. Q. In what time is it so increased?

25

6

150 27.25

27.25
25
2.25
100
150)225.00(1.5
750
00

The Anſwer 1 year and an half.

Prop. IV.

A Sum of Money = p, *being forborn a certain time* = t, *and at the end of that Term did amount to a Sum* = A. Q. *At what Rate of Intereſt?*

Equation, $\frac{A - p : \times TP}{tp} = G.$

Or from the Amount ſubduct the Principal, and the Remainder multiply by 100, that Product divided by the Principal multiplied by the Time, the Quotient will be = G the Rate of Intereſt, *per Cent. per Annum.*

Illuſtration.

Queſt. 1. If 250 *l.* forborn 3 years and 6 months, did amount to 324 *l.* 7 *s.* 6 *d.* at what Rate of Intereſt did it ſo increaſe?

250 = p	324.375 = A
3.5 = t	250 = p
1250	74.375 = A—p
750	100 = TP
875	875) 7437.5 (8.5

The Answer is 8 *l.* 10 *s.*

Quest. 2. If 175 *l.* being forborn 7 years, did amount to 248 *l.* 10 *s.* what Rate of Simple Interest *per Cent. per Annum* was it accompted at?

175	248.5
7	175
1225	73.5
	100
	1225) 7350.0 (6 = G

The Answer is 6 *l.*

If one month be taken for the $\frac{1}{12}$ of a year, the business of Interest and Rebate is very easily performed by a small Table of the Amounts of 1 *l.* for any number of months, not exceeding 12; which Table is made by this Analogy, 100 . 106 :: 1 . 1.06.

A

A Table of the Increase of 1 *l. at* 6 *per Cent. per Ann.*

Months.	*Value.*	*Months.*	*Value.*
12	1.06	6	1.03
11	1.055	5	1.025
10	1.05	4	1.02
9	1.045	3	1.015
8	1.04	2	1.01
7	1.035	1	1.005

If the Question be of the Amount of any Sum forborn any number of months, at 6 *per Cent. per Annum*, multiply the given Sum by the Tabular Number for that time, and the Product answers the Question.

Example.

If 125 *l.* be forborn 10 months, what will it amount to?

The Principal = 125
The Tabular Number for 10 months = 1.05

625
1250

The Answer is 131 *l.* 5 *s.*

If

If the Question be only what is the Interest of any Sum for any time, then multiply the Sum for that time by the Tabular Number less an Unite.

Example.

What is the Interest of 125 *l.* for 10 months?

The Principal = 125
The Tabular Number less an Unite = .05

6.25

The Answer is 6 *l.* 5 *s. prout supra.*

For Discount or Rebate of any Sum, to be forborn, the present worth is found by dividing the given Sum by the Tabular Number.

Example.

What is the present worth of 131 *l.* 5 *s.* due at the end of 10 months?

1.05) 131.25 (125
2 62
525
0

The Answer is 125 *l.*

But if any desire to be more exact, let him multiply the Interest of 1 *l.* for 1 day (which

is

is .000164384) by the number of days, and that Product by the given Sum; and the laſt Product will be the Intereſt for that Sum forborn the time given.

Example.

What is the Intereſt of 125 *l.* forborn from the Tenth of *March* to the Tenth of *January* following, *viz.* 305 days?

.000164384
305

821920
4931520

.050137120
125

25068560
10027424
5013712

6.26714000

The Anſwer is 6 *l.* 5 *s.* 4 *d. ferè.*

Diſcompt is performed by Diviſion, *viz.* get the Amount of 1 *l.* for the time required, by which divide the given Sum, and the Quote is the preſent worth.

Of Mean Time.

It hath been a cuſtome amongſt Merchants, in their Contracts upon Sale of Commodities, to agree upon divers times of payment, as two three-months, three ſix-months, &c. Now to find a time between theſe, wherein the whole Sum may be paid at one entire Payment without detriment to either Party, the ſubſequent Table doth ſhew upon the firſt inſpection.

A Table for Equation of Time.

	1 is 1.5	1 is 2	1 is 2.5	1 is 3
	2 is 3	2 is 4	2 is 5	2 is 6
	3 is 4.5	3 is 6	3 is 7.5	3 is 9
	4 is 6	4 is 8	4 is 10	4 is 12
2	5 is 7.5	3 5 is 10	4 5 is 12.5	5 5 is 15
	6 is 9	6 is 12	6 is 15	6 is 18
	7 is 10.5	7 is 14	7 is 17.5	7 is 21
	8 is 12	8 is 16	8 is 20	8 is 24
	9 is 13.5	9 is 18	9 is 22.5	9 is 27

	1 is 3.5	1 is 4	1 is 4.5	1 is 5
	2 is 7	2 is 8	2 is 9	2 is 10
	3 is 10.5	3 is 12	3 is 13.5	3 is 15
	4 is 14	4 is 16	4 is 18	4 is 20
6	5 is 17.5	7 5 is 20	8 5 is 22.5	9 5 is 25
	6 is 21	6 is 24	6 is 27	6 is 30
	7 is 24.5	7 is 28	7 is 31.5	7 is 35
	8 is 28	8 is 32	8 is 36	8 is 40
	9 is 31.5	9 is 36	9 is 40.5	9 is 45

The

The manner of making this Table, is no more than adding one Term to the given number of Terms, and take half the Sum.

Example.

Is three four-months given, add 4 to 12, the Sum will be 16, half that Sum, *viz.* 8 months, is the equated Time of Payment.

This indeed is but an approximation, though near enough the truth for practice. That excellent Accomptant Mr. *Collins*, in a Sheet Printed *Anno* 1665. hath taught a more exact way of Equation: *Simple Interest*, *prop.* 4. *Compute* (saith he) *all the present worths, and then by proportion, if all those present worths amounted to the total of all those Payments, what did* 1 l. *amount to in the said time? From the result subtract an Unite, the Remainder is the Interest of* 1 l. *for the time sought, which divide by the Interest of* 1 l. *for one Day, and the Quote is the Number of Days sought.*

Example.

A Merchant sold Wines for 300 *l.* and hath given the Vintner three six-months for Payment, *viz.* to pay 100 *l.* at the end of 6 months, another at 12, and the third 100 *l.* at 18 months end; the Question is, At what time may this Vintner pay 300 *l.* together, without detriment to himself or the Merchant.

1.03) 100.0 (97.087
730
900
760
19

1.06) 100.0 (94.339
460
360
420
1020
66

1.09) 100.0 (91.825
190
890
280
620
66

100 *l.* at 6 months is worth — 97.087
100 *l.* at 12 months is worth — 94.34
100 *l.* at 18 months is worth — 91.826

The present worths = 283.253

283

283.253) 300.00000 (1.059123786
1674700
2584350
350730
674770
1072640
2228810
2460390
1943660
240142

The Interest of 1 *l.* for the time is .059123786
The Interest of 1 *l.* for 1 day is = .000164384

.000164384) .059123786 (359.6
980858
1589346
19930

The Answer is 359 days and a half, *fere.*

By the Table, three six-months gives twelve months for the equated time, which you find above five days less than a year by this Calculation.

A Decimal Table *of the present worth of One Pound, Quarterly Payment, at* 6 per Cent. per Annum, *Simple Interest, for* 124 *Quarters.*

1	.985222	21	18.136533
2	1.956095	22	18.888413
3	2.913033	23	19.631907
4	3.856429	24	20.367201
5	4.786662	25	21.094474
6	5.704093	26	21.813898
7	6.609071	27	22.525642
8	7.501928	28	23.229868
9	8.382985	29	23.926732
10	9.252550	30	24.616387
11	10.110919	31	25.298981
12	10.958377	32	25.974656
13	11.795197	33	26.643553
14	12.621643	34	27.305804
15	13.437970	35	27.961542
16	14.244421	36	28.610893
17	15.041234	37	29.253979
18	15.828636	38	29.890922
19	16.606846	39	30.521837
20	17.376077	40	31.146837

41	31.766032	66	45.627833
42	32.379529	67	46.125686
43	32.987432	68	46.621636
44	33.589841	69	47.113036
45	34.186856	70	47.600841
46	34.778572	71	48.085103
47	35.365082	72	48.565872
48	35.946478	73	49.043199
49	36.522847	74	49.517133
50	37.094275	75	49.987721
51	37.660848	76	50.455010
52	38.222645	77	50.919048
53	38.779748	78	51.379877
54	39.332235	79	51.837543
55	39.880180	80	52.292088
56	40.423658	81	52.743556
57	40.962742	82	53.191986
58	41.497501	83	53.637421
59	42.028005	84	54.079898
60	42.554321	85	54.519459
61	43.076514	86	54.956140
62	43.594649	87	55.389980
63	44.108787	88	55.821014
64	44.618992	89	56.249280
65	45.125321	90	56.674811

91	57.097644	111	65.035628
92	57.517813	112	65.408763
93	57.935349	113	65.779820
94	58.350287	114	66.148824
95	58.762658	115	66.515796
96	59.172494	116	66.880760
97	59.579826	117	67.243736
98	59.984684	118	67.604747
99	60.387099	119	67.963814
100	60.787099	120	68.320956
101	61.184713	121	68.676196
102	61.579970	122	69.029553
103	61.792897	123	69.381047
104	62.363522	124	69.730697
105	62.751872		
106	63.137972		
107	63.521849		
108	63.903529		
109	64.283035		
110	64.660394		

The Use of the precedent Table is principally to shew the present worth of any Lease or Annuity, payable Quarterly, for any term of years under 21, at *6 per Cent. per Annum*, Simple Interest.

Example.

Example.

There is a Leaſe for 18 years to be ſold, of the yearly value of 160 *l.* payable Quarterly, *viz.* 40 *l. per* Quarter, what is this Leaſe worth in ready money, allowing the Purchaſer *6 per Cent.* Simple Intereſt?

72 Quarters *per* Table = 48.565872

40

1942.634880

The Anſwer is 1942 *l.* 12 *s.* 8 *d.* $\frac{1}{4}$ *ferè.*

The Inverſion of the Queſtion, *viz.* What Quarterly Payment for 18 years will 1942 *l.* 12 *s.* 8 *d.* $\frac{1}{4}$ purchaſe?

As the former was done by Multiplication, where the Product exhibits the Anſwer; ſo if the Sum propoſed be divided by the Tabular Number, the Quote gives your Anſwer.

Example.

48.565872) 1942.63488 (40
0000 00000

The Anſwer is 40 *l.*

Of Compound Intereſt.

AS Simple Intereſt is performed by a Series of Muſical, ſo is Compound Intereſt wrought by a Rank of Geometrical continual Proportionals. The operation whereof by the Canon of Logarithms, take under theſe four Conſiderations.

Prop. I.

If you ſhall put p = *the Logarithm of a Principal or Sum forborn, and* t = *the time of forbearance in years, quarters, months, or days,* r = *the Logarithm of the Rate of Intereſt,* per cent. per annum, per menſem, *or* per diem, a = *the Logarithm of the Amount of the ſaid Principal for the ſaid time, at the Rate alſo aforeſaid: Then* Q. *The Amount* = a?

Equation, $a = r\,t + p$.

That is, Multiply the Logarithm of the Rate by the Number of Years, Quarters, &c. to which Product add the Logarithm of the Principal, and the Aggregate is equal to the Logarithm of the Amount.

Example.

Example.

Queſt. 1. If 175 *l.* be forborn 7 years, what will it amount to at 6 *per Cent. per Annum*, Compound Intereſt?

Log. of the Rate = 0,02530586 = *r*
7 = *t*

0,17714105
Log. of the Sum = 2,24303805 = 175 = *p*

2,42017910 = 263.135

The Anſwer 263 *l.* 2 *s.* 8 *d.* $\frac{1}{4}$ *ferè.*

Queſt. 2. If 1000 *l.* be forborn for 6 months, at 6 *per Cent. per Annum*, Compound Intereſt, what will it amount to?

Log. of the former Rate divided by 12, the months in a year, is = 0,00210882 = *r*
6 = *t*

0,01265292
Add the Log. of 1000 *viz.* 3,00000000

1029.563 = Log. Amount 3,01265292 = *a*

The Anſwer 1029 *l.* 11 *s.* 3 *d. ferè.*

Prop. II.

A Sum of Money unknown, being forborn a certain time = t, *at a given Rate of Intereſt* = r, *is amounted to a given Sum* = a; Q. *What was* p?

Equation, $p = a - rt$.

From the Logarithm of the Amount, ſubduct the Logarithm of the Rate, multiplied by the time, and the Remainder is the Logarithm of the Principal.

Example.

Queſt. 1. If 263 *l.* 2 *s.* 8 *d.* $\frac{1}{4}$ be the Amount of a Sum forborn 7 years, at 6 *per Cent. per Annum*, Compound Intereſt, what was the Principal?

Log. of the Rate = 0,02530586 = *r*
7 = *t*

0,17714105 = *rt*
Log. of the Amount 2,42017910

Log. of the Principal 2,24303895 = *p* = 175

The Anſwer 175 *l.*

Queſt.

Queſt. 2. If 102 *l.* 11 *s.* 3 *d.* be the Principal and Intereſt of a Sum of Money forborn 6 months, at 6 *per Cent. per Annum*, Compound Intereſt, what was the Principal?

Log. of Rate for 1 m°. 0,00210882
6
0,01265292
Log. of 1029.563 = 3,01265292
Log. of the Principal 3,00000000 = 1000
The Anſwer 1000 *l.*

Prop. III.

A Sum of Money = p, *being forborn for a time* = t, *did amount to a given Sum* = a, *at a Rate of Intereſt unknown*: Q. *The Rate* per Cent. per Annum = r?

Equation, $r = \frac{a - p}{t}$.

Divide the Logarithm of the Amount, leſs the Logarithm of the Principal, by the Time, and the Quote is the Logarithm of the Rate.

Example.

If 25 *l.* forborn 4 years, did amount to 31 *l.* 11 *s.* 2 *d.* $\frac{1}{4}$; at what Rate of Compound Intereſt did it ſo increaſe?

Loga-

Logarithm of the Amount = 1,49808345
Logarithm of the Principal = 1,39794001

$a - p$ divide by 4) 0,10014344

The Log. of the Rate = r = 0,02503586

Prop. IV.

A Sum of Money being forborn, at a given Rate, for a time unknown, but the Amount is known, how long was it so forborn?

Equation, $t = \frac{a - p}{r}$.

Example.

If 1000 *l.* be increased to 1029 *l.* 11 *s.* 3 *d.* at 6 *per Cent. per Annum*, Compound Interest, in what time was it so increased?

r = 0,00210882 $a - p$ = 0,01265302(6
00000010

The Answer 6 months.

It may here be expected that I should lay down the Construction of the Logarithms, having made use of them in these Calculations, but this being design'd a small *Enchiridion*, and there being large Volumns of that Subject in the World already, by several more learned Pens, I think it unnecessary to say any thing further

further thereof, for as they are of excellent uſe, ſo are they eaſie to be had.

COmpound Intereſt *Infinite*, may be ſo called as it relates to divers equal Payments at equal times, but the number of thoſe equal times are infinite, *(i. e.)* when an Eſtate in Fee-Simple ſhall be ſold for ever. Now there being uſually an interval of time, between the Purchaſers Payment and the reception of his firſt Rent, be it yearly, half yearly, or quarterly;

Any Queſtion of this Nature may be wrought by the following Analogiſm:

Putting V = the Rent (yearly or quarterly) and S = the Price paid for the Land, alſo R = the Common Factor of the Rate of Intereſt, *per Cent. per Annum.*

Hence then may ariſe theſe three Propoſitions.

Prop. I.

There is a Fee Simple to be ſold, what is it worth in ready money, ſo that the Purchaſer may have 6 per Cent. per Annum, *Compound Intereſt, allowed for his money.*

Queſt.

Queſt. 1. There is a Manour to be ſold of the clear yearly value of 969 *l.* 18 *s.* what Sum of ready money is this Eſtate worth, *6 per Cent. per Annum* Compound Intereſt being allowed the Purchaſer for his money?

Equation, $\frac{V}{R-1} = S$.

The Annual (or Quarterly) Payment, divided by the Ratio, leſs Unity, exhibits the Sum in the Quotient.

$R-1 = .06$) 969.9 (16165
36
09
39
30
—
0

The Anſwer is 16165.

Queſt. 2. There is an Eſtate of 969 *l.* 18 *s.* *per Annum*, payable Quarterly, what is it worth in ready money, allowing the Purchaſer 6 *per Cent. per Annum* Compound Intereſt?

.014674

R—1 V S

.014674) 242.475 (16524.124

14674

95735

88044

76910

73370

35400

29348

60520

58696

18240

14674

35660

29348

63120

58696

4424

The Answer is 16524 *l.* 2 *s.* 6 *d. ferè.*

The difference between Yearly and Quarterly Payments in this Purchase raiseth the value 359 *l.* 2 *s.* 6 *d.*

☞ Having the increase of 1 *l.* for a Year, at any Rate of Interest, the Biquadrate Root of that Increase, is the Increase of 1 *l.* for a Quarter at Compound Interest. Prop.

Prop. II.

A Sum of money lying ready for a Purchase, and it be desired to know what Free-hold Estate such a Sum will purchase, if laid out at a given Rate per C. per Ann. *Compound Interest.*

Theorem, $V = S \times R - 1$.

Or, in other terms, the Sum of Money multiplied by the Rate, less Unity, the Product shall be equal to the Annual half quarterly or quarterly Payment.

Quest. A Gentleman upon Marriage of his Daughter promiseth to lay out 1600 *l.* for a Free-hold Estate, to be settled upon her and her Heirs, provided he meet with such a Pennyworth as shall bring 8 *per Cent. per Annum*, Compound Interest for his money: *Q.* What Annual Rent must it be?

$$1600 = S$$
$$.08 = R - 1$$

$$V = 128.00$$

The Answer 128 *l. per Annum.*

Prop. III.

An Estate being offered for a certain Sum of money, the annual Rent is also known: Q. What Rate

Rate of Intereſt upon Intereſt ſhall the Purchaſer have for his money?

$$\text{Equation, } \frac{V}{S} = R - 1.$$

The annual Rent being divided by the Sum demanded, quotes the Rate leſs Unity.

Example.

Queſt. 1. There is a Free-hold Eſtate to be ſold for 1600 *l.* the yearly Rent being 128 *l.* what Rate of Intereſt ſhall the Purchaſer have for his money?

1600) 128.000 (.08 = R — 1.
Add 1.00

1.08 = R.

Queſt. 2. Admit there be a ſmall Farm to be ſold of the Value of 35 *l. per Annum* for 500 *l.* what Rate of Compound Intereſt ſhall the Purchaſer have for his money at that price?

500) 35.00 (.07 = R — 1.
Add 1.00

1.07 = R.

Fur-

Furthermore, if it be inquired how many years Purchaſe any Annuity is worth, putting R = the Ratio as before, and Y the number of Years, the Rule is:

$$\frac{1}{R-1} = Y.$$

That is, Divide Unity by the Ratio leſs 1, and the Quote informs the Number of Years.

Example.

There is a Free-hold Eſtate to be ſold, *Q.* How many Years Purchaſe is it worth at 5 *per Cent. per Annum?*

.05) 1.0 (20

0

The Anſwer is 20 Years Purchaſe.

What is it worth at 6 *per Cent. per Annum?*

.06) 1.0 (16,666

40

40

40

4

The Anſwer is 16 Years, and $\frac{2}{3}$ of a Year.

Again

Again, if an Eſtate be offered at any number of Years Purchaſe, and it be demanded what Rate of Intereſt the Purchaſer ſhall have for his Money, the Rule is:

$$R = \frac{1}{Y} + 1.$$

That is, Divide Unity by the number of Years propos'd, and the Quote exhibits the Ratio, leſs Unity.

Example.

An Eſtate is offered at 20 Years Purchaſe, what Rate of Intereſt ſhall the Purchaſer then have?

20) 1.00 (.05
Add 1.00

1.05

The Anſwer is 5 *per Cent. per Annum.*

There are many Tables of Compound Intereſt Printed in ſundry Books for the valuation of Leaſes and Annuities, but they are generally made for yearly Payments, when indeed by the common and moſt uſual Covenants in Leaſes the Tenant is obliged to pay quarterly; and in Leaſes of great value, there will be found a conſiderable difference in the true worth, (ſo great, that 25 *l. per* Quarter is as good as 102 *l.* 5 *s. per Annum.*) I have therefore preſented the Reader with a Table fitted to ſuch Quarterly Payments, the Uſe of which Table I doubt not but will be very eaſily found by the Examples that follow.

A Table of Intereſt, *for the Valuation of Leaſes or Annuities for Quarterly Payments, at* 6 per Cent. per Annum, *Compound Intereſt, for* 31 *Years.*

1	.985538	21	17.960417
2	1.956824	22	18.686219
3	2.914064	23	19.401524
4	3.857459	24	20.106484
5	4.787213	25	20.801250
6	5.836372	26	21.485968
7	6.609520	27	22.160789
8	7.496573	28	22.825841
9	8.373700	29	23.481282
10	9.238139	30	24.127242
11	10.090079	31	24.763844
12	10.929724	32	25.391256
13	11.757176	33	26.009595
14	12.572685	34	26.618988
15	13.376402	35	27.219206
16	14.168496	36	27.811474
17	14.949134	37	28.394861
18	15.718484	38	28.969764
19	16.476707	39	29.536352
20	17.223982	40	30.094714

41	30.645034	66	42.092531
42	31.187396	67	42.469245
43	31.721914	68	42.841611
44	32.248000	69	43.206601
45	32.767870	70	43.567307
46	33.279531	71	43.922768
47	33.783794	72	44.273138
48	34.280753	73	44.618415
49	34.843000	74	44.958701
50	35.253244	75	45.194062
51	35.728999	76	45.624577
52	36.197819	77	45.950311
53	36.659861	78	46.271331
54	37.115237	79	46.587715
55	37.564028	80	46.899521
56	38.006330	81	47.206817
57	38.442234	82	47.509668
58	38.871893	83	47.808141
59	39.295222	84	48.102298
60	39.712487	85	48.392200
61	40.123777	86	48.677877
62	40.529043	87	48.959492
63	40.928469	88	49.236993
64	41.322133	89	49.510486
65	41.710087	90	49.780023

91	50.045601	111	54.620966
92	50.307460	112	54.816601
93	50.665471	113	55.009461
94	50.819753	114	55.199474
95	51.070356	115	55.386751
96	51.317335	116	55.571297
97	51.560742	117	55.753185
98	51.841984	118	55.932443
99	52.037044	119	56.109107
100	52.271047	120	56.283219
101	52.499677	121	56.454811
102	52.725986	122	56.623921
103	52.949021	123	56.790588
104	53.134301	124	56.954843
105	53.385474		
106	53.598963		
107	53.809375		
108	54.016743		
109	54.221113		
110	54.422527		

The Calculation of a Number in the precedent Table, by aid of the Canon.

The Queſtion being, What is the preſent worth of 1 *l. per* Quarter for 21 Years?

The Logarithm of the Increaſe of 1 *l.* at 6 *per Cent.* for three months = 0,006326466 4
The Number of Quarters = 84

25305865 6
506117312

Diſcompt of 1 *l.* for 84 Qrs. 0,5314231776

Then by the Rule of Proportion:

If 1.4673846 17 *com. arithm.* 9,8334569382
have 100 *l.* for its Principal, 2,0000000000
what ſhall 1 *l.* have for its Pr. 0,0000000000

68.148601 = 1,8334569382
The Log. of the Diſcompt = 0,5314231776

20.046279 1,3020337606

48.102322

The Anſwer is = 48 *l.* 2 *s.* 0 *d.* ½ *fere.*

And after this manner may a Table be Calculated, or the Value of a Leaſe for any Number of Years, may be found at any Rate of Intereſt required.

The USE of the TABLE.

This Table ſheweth the Diſcompt of 1 *l.* *per* Quarter at 6 *per Cent. per Annum*, Compound Intereſt, and if the Tabular Number for ſo many Quarters as the Leaſe is to continue be multiplied by the Quarterly Payment, that Product is the preſent Value of that Leaſe in ready money.

Example.

A Leaſe of 40 *l. per Annum* (*viz.* 10 *l. per* quarter) for 21 years, being to be ſold, what is it worth in ready money?

84 quarters *per* Table = 48.102221
The quarterly Rent = 10

481.022210

The Anſwer is 481 *l.* 0 *s.* 5 *d* $\frac{1}{4}$ *ferè.*

But if the queſtion be, What quarterly Rent for 21 years will a given Sum purchaſe? Then divide the given Sum by the Tabular Number for ſo many quarters.

Example.

48,102221) 481.022210 (10
000000

A Gentleman having a Leaſe of certain Church Lands, worth 200 *l. per Annum* more than the reſerved Rent, for 14 years to come, ſurrenders the ſame, upon condition the Chapter ſhall make him a new Leaſe for 31 years without a preſent Fine, but advancing the old Rent 10 *l. per* quarter during the whole term of 31 years; what doth he gain by the bargain, accompting Compound Intereſt on both ſides?

56 quarters *per* Table = 38.000
The quarterly Rent = 50
1900.300

124 quarters *per* Table = 56.955
40
2278.200
1900.300
377.9

The Anſwer is 377 *l.* 18 *s.* the new Leaſe being ſo much more worth than the old one.

240 *l.* is demanded for the Leaſe of a Houſe for 7 years, the Tenant offers 100 *l.* and an advance of Rent equivalent to the reſt of the Fine required, what ought this Rent to be?

28 quarters = 22.8258)140.0000(6.1334
304520
762620
778460
936760

The Advance of Rent ought to be 6 *l.* 2 *s.* 8 *d. per* quarter.

There is a Leaſe of 200 *l. per Annum*, *viz.* 50 *l. per* quarter, for 13 $\frac{1}{4}$ years, to be ſold, what is it worth at 6 *per Cent.* Simple, and what at 6 *per Cent.* Compound Intereſt?

Simple.

53 quarters *per* Table = 38.779748
50

1938.987440

Compound.

53 quarters *per* Table = 36.659861
50

1832.993050

Which ſubtracted from 1938.987440

Leaves 105.99439

Whereby it appears, that it is cheaper to the Purchaſer at Compound Intereſt than at Simple Intereſt by 106 *l.*

Six

Six Queſtions performed by the aid of the Canon of Logarithms.

Queſt. 1. A Gentleman pays 350 *l.* for a Leaſe in Reverſion, to commence at the end of 13 years and a quarter, and to continue for 21 years and 3 quarters, what quarterly Rent may he lett the Premiſes for, after he comes to be in poſſeſſion thereof, ſo as to gain 8 *per Cent.* Compound Intereſt for his money?

The Logarithm of 350 *l.* = 2,544008
Worth of 1 *l.* forborn 53 quarters = 0,442865

Log. of the Increaſe of 350 *l.* = 2,986873
Worth of 1 *l.* for 87 quarters = 1,621420

Log. of 23.198 = 1,365453

The Anſwer = 23 *l.* 3 *s.* 11 *d.* $\frac{1}{2}$ *ferè.*

Queſt. 2. A Citizen having taken a Leaſe of a Houſe and Shop for 21 years, at 370 *l.* Fine, and 100 *l. per Annum*, *viz.* 25 *l. per* quarter, Rent, at the end of two years is willing to leave it for 300 *l.* and the old Rent, or to have ſuch an increaſe of Rent, during the whole term yet to come, as may reimburſe him his Fine paid, with Compound Intereſt at 6 *per Cent. per Annum:* What ought

ought he to receive in advance of Rent, and what doth he offer to loſe of his Fine paid in taking 300 *l.*

2,568202 = 370 *l.*
1,682165 = The worth of 1 *l. per* quarter for 84 quarters.
0,886037 The Advance of Rent ought to be 7 *l.* 13 *s.* 10 *d.* $\frac{1}{4}$ *ferè.*
1,652198 The worth of 1 *l. per* quarter for 76 quarters.
2,545235 The preſent Fine ought to be 350 *l.* 18 *s.* 10 *d.*

Whereby it appears, there is 50 *l.* 18 *s.* 10 *d.* offered to be loſt in putting off the Houſe and Shop aforementioned.

Queſt. 3. *A* ſells a Houſe to *B* for 800 *l.* to be paid with Intereſt upon Intereſt by 100 *l. per Annum*, *viz.* 25 *l. per* quarter, how many quarters Rent ought *B* to pay before *A* is ſatisfied for his 800 *l.* with Compound Intereſt at 6 *per Cent. per Annum*, and what ought the laſt Payment be?

As

As 1.46738	*co. ar.*	9,833457
to 100		2,000000
So 25		1,397940
to 1703.71		3,231397
800		
903.71	Its Logarithm =	2,956028
		0,275369

Log. of 1 *l.* forborn 1 quarter 0,006326

0,006326) 275369 (43 quarters.
22329

3351

The Rent 25 1,397940

1 *l. per* quarter for 43 quarters 1,501359

793.047 = 2,899299
800

6.953 its Logar. 0,841049

Log. of amount of 1 *l.* for 44 quarters 0,278364

1,119413

The laſt Payment 13 *l.* 3 *s.* 4 *d. ferè.*

Queſt.

Queſt. 4. *A* lends unto *B* a certain Sum of ready money, and accepts a Rent Charge of 40 *l.* quarterly for 7 years in ſatisfaction, finding it paid him his Principal with Intereſt upon Intereſt at 8 *per Cent.* within 13 *l.* 4 *s.* 6 *d.* what was the Money lent?

1,602060 The Logarithm of 40 *l.*
1,565196 The Logarithm of the worth of 1 *l.*
——————— quarterly for 48 quarters.
3,167256 The Logarithm of the worth of 40 *l.* *per* quarter for 48 quarters.

3,167256 = 1469.787
13.225

3,163328 = 1456.562
0,177140 The Logarithm of the increaſe of
——————— 1 *l.* forborn 28 quarters.
2,986188 The Logarithm of 968.7.

The Money lent was 968 *l.* 14 *s.*

Queſt. 5. A Teſtator leaving one Son and two Daughters, bequeaths out of his Eſtate (being 600 *l.* *per Annum* for 11 years) to his eldeſt Daughter 500 *l.* *per Annum* for 4 years next coming, at the end whereof, to his younger Daughter 300 *l.* *per Annum* for 7 years, and to his Son the Remainder of the Eſtate

Eſtate for the whole time: 2. Which had the greateſt Portion, and by how much, calculating their ſeveral Annuities at *6 per Cent.* Compound Intereſt?

0,539716 Logarithm of the worth of 1 *l. per annum* for 4 years.
2,698970 The Logarithm of 500 *l.*

3,238686 = 1732.55.

0,746820 The Logarithm of the worth of 1 *l. per annum* for 7 years.
2,477121 The Logarithm of 300 *l.*

3,223941
0,101232 The Logarithm of the worth of 1 *l.* forborn 4 years.
3,122709 = 1326.47.

0,896905 The Log. of the preſent worth of 1 *l. per annum* for 11 years.
2,000000

2,896905 = 788.58

0,746820

0,746820 The Log. of the present worth of 1 *l. per annum* for 7 years.
2,301029 The Logarithm of 200 *l.*

3,047849
0,101232 The Logarithm of the worth of 1 *l.* forborn 4 years.
2,946617 = 884.34
788.68

1673.02

The Sons Portion ——— 1673 : 00 : 05
The eldest Daughters Portion 1732 : 11 : 00
The youngest Daughters — 1326 : 09 : 04¾

4731 : 19 : 09¾

Proof.

0,896905 The Logarithm of the worth of 1 *l. per annum* for 11 years.
2,778151 The Logarithm of 600 *l.*

3,675056 The Logarithm of 4732 *l.*

Quest. 6. A Merchant sold 16 Kintals of *Cyprus* Cottons for 320 *l.* to be paid at two six-months; the Buyer having Money by him, offers to pay the Money presently, pro-

provided the Merchant allow him Diſcompt at *6 per cent.* Compound Intereſt. *Q.* What ought the Merchant to receive?

2,505149 The Logarithm of 320 *l.*
0,018979 The Logarithm of 1 *l.* forborn 9 months, the equated time, according to the Table of Mean Time, *Pag.* 110.
2,486170 The Logarithm of 306.316.

The Anſwer 306 *l.* 6 *s.* 4 *d. ferè.*

STEREOMETRY:

OR,

A New and the moſt Practical Way

OF

Gauging Tunns

In the form of a

PRISMOID & CYLINDROID:

ALSO

The *Fruſtums* of *Pyramids* and of a *Cone*;

Together with

The *Art* of *CASK-GAUGING.*

By *John Mayne.*

London, Printed by *William Godbid*, for *Nath. Crowch*, in *Exchange-Alley*.
M. DC. LXXIII.

TO THE
Young Geometrician.

I *Hope by this time thou art ſo ſufficiently acquainted with the Nature and Uſe of a Decimal Fraction, that any Operation in the ſix Species*, viz. Addition, Subtraction, Multiplication, Diviſion, Involution *and* Evolution *of the* Second *and* Third Powers, *will not appear difficult to thee; and theſe being familiar, any Calculation in* Arithmetick, Geometry, Trigonometry, *or other* Mathematical Arts, *will not ſeem ſtrange: Amongſt the many pleaſant Walks in this* Tempe, *I have made it my preſent deſign to give thee ſome diverſion in that part of* Solid Geometry *called* Gauging, *and herein paſſing by thoſe Bloſſoms that kiſs the hand of every Paſſenger, I have endeavoured (and I hope not altogether without ſucceſs) to ſhew thee how to gather a Roſe without danger of its Thorn: For the In-*

vention, the World is obliged to the Ingenious Mr. Michael Dary, *the Roots of these, and many other choice Mathematical Flowers, lying crowded together in a small Treatise called* Dary's Miscellanies, *Printed* 1669. *Here, as in the former Part, thou hast both Precept and Example in the plainest method I could possibly express them. That they may by no means seem obscure to any ingenious Student, is the hearty desire of*

Thy Friend,

J. M.

The

The Explanation of the Signs or Characters.

+	*More.*
−	*Leſs.*
=	*Equal.*
>	*Greater.*
<	*Leſſer.*
×	*Multiplied.*
√	*Square Root.*
q	*Square.*
⊖	*Circle.*
::	*Proportional.*
∽	*Difference.*

The Explanation of the Signs or Characters.

+	More.
−	Less.
=	Equal.
>	Greater.
<	Lesser.
∴	Therefore.
∵	Because.
∷	Proportional.
○	Circle.
∥	Square.
□	Square etc.
∠	Angle.
∽	Difference.

STEREOMETRY:

OR,

A New and the moſt Practical Way of GAUGING TUNNS, &c.

A plain and eaſie Method for finding the Solid Content of a Priſmoid.

DEFINITION.

BY the word *Priſmoid* is to be underſtood a Solid contained under ſix plain Surfaces, whereof the two Baſes ought to have theſe three qualifications:

1. Rectangular Parallelograms.
2. Parallel.
3. Alike Situate. *i. e.* So ſituate, that the Rectangular Conjugates in both Baſes may be inſerted by two and the ſame Planes, and a Right Line extended from the Center of one Baſe to the other may be called the Axis, and the other remaining four Planes are the *Peri-*

pataſma. Under this Definition is comprehended the Fruſtums of Pyramids and Priſms.

Note alſo, If the *Peripataſma* be not made by the four flat Sides (ſpoken of before) but ſhall be conſtituted by Curveture from Circles or Eliſe's, the Solid is then called a Cylindroid, and under this Definition is comprehended Fruſtums of Cones and Cylinders.

PROBL.

If in a *Priſmoid* you put

~~G = the whole Content thereof.~~

A & B = *the two Rectangular Conjugates above.*

G & H = *the two Rectangular Conjugates below.*

A & G oppoſite = *their two Correſpondents one above the other below inſerted by one Plane.*

B & H oppoſite = *their two Correſpondents above and below, and alſo inſerted by one Plane.*

P = *the perpendicular height of the Priſm or Priſmoid.*

K = *the increment of any two Diameters, to be taken between* A *and* G *in the ſame Plane with them, at one Inch diſtance of the perpendicular.*

L = *the increment of any two Diameters, to be taken between* B *and* H *in the ſame Plane with them, at one Inch diſtance of the perpendicular.*

Then,

Then,

Analogiſm.

$$)GHp+\frac{1}{2}\left\{\begin{matrix}GL\\HK\end{matrix}\right\}pp+\frac{1}{3}KLppp(=C.$$

Or,

The Rectangle of the two Diameters at the Baſe multiplied into the Perpendicular, more the Semi-ſum of G L and H K, (*viz.* thoſe two Diameters multiplied into their altern increments) multiplied into the Square of the Perpendicular, to which add one third of the Rectangle of K L (*i. e.*) the two increments multiplied into the Cube of the Perpendicular is equal to the Content in Cubick Inches.

By which *Theorem* you find three fixed or ſtationary Numbers, which Mr. *Dary* calls *reſerved Coefficients*, wherefore you ſhall find them hereafter called by that denomination: Theſe three reſerved Coefficients thus multiplied into the Perpendicular; the Product is equal to the whole Content, or by any part of the Perpendicular gives the Solidity of that part.

Prop. I.

Having a Tunn in the form of a Priſmoid, the Dimenſions being,

above. *above.*
A = 126 *and* B = 144
below. *below.*
G = 102 *and* H = 108 } *Inches.*
P = 60

What

What is the Solidity of this Tunn in Cubick Inches?

First then to find the three reserved Coefficients.

$$\begin{array}{c} A - G \\ P = 60\,)\,24.0\,(\,.4 = K. \end{array}$$

i. e. The difference between A and G (the two opposite Diameters above and below) divided by the Perpendicular quotes K, the increment of any two Diameters to be taken between them, at one Inch distance in the Perpendicular, and in the same Plane.

$$\begin{array}{c} B - H \\ P = 60\,)\,36.0\,(\,.6 = L. \end{array}$$

That is, the difference between B and H (the two Diameters opposite the one above the other below) divided by the Perpendicular quotes L, the increment of any two Diameters to be taken between them, at one Inch distance in the Perpendicular, and in the same Plane with them.

$$\begin{array}{l} .6 = L \\ .4 = K \\ \hline .24 = \text{The Rectangle of L K} \\ \hline .08 = \tfrac{1}{3} \text{ of L K, the first Coefficient.} \end{array}$$

102 = G
.6 = L

61.2 = GL
43.2

104.4 = GL + HK

52.2 = ½ GL + HK, the second Coefficient.

102 = G
108 = H

816
1020

11016 = GH, the third Coefficient.

108 = H
.4 = K

43.2 = HK

Now having found these reserved Coefficients, I proceed, and finding that ⅓ of KL must be multiplied by the Cube of the Perpendicular, I begin with it, and call that the first Coefficient; then ½ $\left\{\begin{matrix} GL \\ HK \end{matrix}\right\}$ being to be multiplied by the Square of the Perpendicular, I add that to the first Fact, and call it the second Coefficient; lastly, GH being to be multiplied by the Perpendicular, I add that to the second Fact, and call it the third Coefficient; then will the Work stand thus:

Example

Example.

.08 = first Coefficient.
60 = the Perpendicular.

4.80
52.2 = second Coefficient.

57.0
60 = the Perpendicular.

3420
11016 = third Coefficient.

14436
60 = the Perpendicular.

The Answer 866160 Cubick Inches.

Now admitting this Tunn have but 33 wet Inches; what is the Content thereof?

.08
33

24
24

2.64
52.2

54.84

54.84
33
16452
16452
1809.72
11016
12825.72
33
3847716
3847716

The Anſwer = 423248.76 Cubick Inches.

Prop. II.

Having a Tunn in the form of a Priſmoid, the Dimenſions being,

above. *above.*
G = 102 *and* H = 108
below. *below.*
A = 126 *and* B = 144 } *Inches.*
P = 60

What is the Solidity in Cubick Inches?

To find this Tunns Solidity, the Rule is:

$$AB\,p - \tfrac{1}{2}\left\{\begin{matrix}AL\\BK\end{matrix}\right\}pp + \tfrac{1}{3}KL\,ppp = \text{Content.}$$

i. e. The Fact of A B (the rectangular Conjugates

gates at the Baſe) multiplied by the Perpendicular, from whence ſubduct the Semi-ſum of the two Facts (A and its altern decrement, B and its altern decrement, multiplied into the Square of the Perpendicular) more the one third of the Rectangle of KL, *viz.* the two decrements, multiplied into the Cube of the Perpendicular, and that Remainder is the Content in Cubick Inches.

To find the Coefficients.

$$\frac{G-A}{P=60)-24.0(-.4=K.}$$

$$\frac{H-B}{P=60)-36.0(-.6=L.}$$

This Rule being the Converſe of the former, theſe Numbers K and L which before were Affirmatives are now become Negatives (then increment, now decrement;) the greater Conjugates being ſubducted from the leſſer makes the Dividends ſo much leſs than nothing, and conſequently the Quotes, the Diviſor being an Affirmative, yet theſe two Negatives being multiplied together, their Fact becomes Affirmative, according to the Rule of *Algebra*, the Signs of the Factors being homogeneal (or alike) makes the Fact more, as in this

Example.

Example.

$-.6 = L$
$-.4 = K$

$+.24$

$+.08 = \frac{1}{3}$ LK the first Coefficient.

$126 = A$ $\quad$ $144 = B$
$-.6 = L$ $\quad$ $-.4 = K$

-75.6 $\quad$ 57.6
-57.6

-133.2

$-66.6 = \frac{1}{2}$AL + BK, second Coefficient.

The Factors in these Rectangles being heterogeneal (or unlike) the Fact is made less.

$126 = A$
$144 = B$

504
504
126

18144 The third Coefficient.

These two Factors being both Affirmatives, the Fact is +.

With

With these three reserved Coefficients I proceed to the Calculation, according to the precedent Theorem.

+.08 = the first Coefficient.
60 = the Perpendicular.

+4.80
−66.6 = second Coefficient.

−61.8
60 = the Perpendicular.

−3708.0
+18144 = third Coefficient.

14436
60 = the Perpendicular.

The Answer = 866160 Cubick Inches.

But if this Tunn have only 27 Inches of the Perpendicular wet, the Content then being required:

+.08
27

56
16

2.16
−66.6

−64.44

−64

—64.44
27

45108
12888

—1739.88
+18144

+16404.12
27

11482884
3280824

The Answer = 442911.24 Cubick Inches.
423248.76

Proof. 866160

Prop. III.

There is a Tun in the form of a Prismoid, the Dimensions are,

above. *above.*
A = 132 *and* B = 144
below. *below.*
G = 108 *and* H = 108 } *Inches.*
P = 60

What is the Solidity in Cubick Inches?

A — G
P = 60) 24.0 (.4 = K.

B — H
P = 60) 36.0 (.6 = L.

.6
.4

.24

.08 = the first Coefficient.

G = 108
L = .6

64.8
43.2

108.0
---
54 = the second Coefficient.

H = 108
K = .4

43.2

108
108

864
1080

11664 = the third Coefficient.

```
   .08
    60
  ----
  4.80
 54
 ----
 58.8
    60
 ----
3528.0
11664
-----
15192
   60
-----
```

The Answer = 911520 Cubick Inches.

Prop. IV.

There is a Tunn in the form of a Prismoid, the Dimensions being,

above. *above.*
G = 108 *and* H = 108
below. *below.*
A = 132 *and* B = 144 } *Inches.*
P = 60

What is its Solidity in Cubick Inches?

The reserved Coefficients are found to be:

G — A
P = 60) — 24.0 (— .4 = K.

$$\begin{array}{l} \qquad\quad H - B \\ P = 60\,)\,-36.0\,(\,-.6 = L. \end{array}$$

$$\begin{array}{r} -.6 \\ -.4 \\ \hline +.24 \\ \hline +.08 \end{array} = \text{the first Coefficient.}$$

$$\begin{array}{rr} A = 132 & B = 144 \\ L = -.6 & K = -.4 \\ \hline -79.2 & -57.6 \\ -57.6 & \\ \hline -136.8 & \\ \hline -68.4 & \end{array} = \text{the second Coefficient.}$$

$$\begin{array}{r} 132 \\ 144 \\ \hline 528 \\ 528 \\ 132 \\ \hline +19008 \end{array} = \text{the third Coefficient.}$$

The

The Calculation.

$$
\begin{array}{r}
+.08 \\
\quad 60 \\
\hline
+4.80 \\
-68.4 \\
\hline
-63.6 \\
\quad 60 \\
\hline
-3816.0 \\
+19008 \\
\hline
+15192 \\
\quad 60 \\
\hline
\end{array}
$$

The Anſwer = 911520 Cubick Inches.

Here note, if any of the precedent Tunns be cloathed by Curveture, (*i. e.* the Baſes being Circular or Elliptical) the laſt Product ought to be divided by 1.27324, then will the Quotient exhibit the Cubick Inches in that Solid. But if the Queſtion be Ale Gallons, let your Coefficients be divided by 282; if Beer Barrels be required, divide the Coefficients by 10152, the number of Inches in a Beer Barrel. In all flat ſided Figures, and for thoſe Solids, whoſe Peripataſma is conſtituted by Circles or Ellipſis, the Diviſor for Beer Barrels is 12926>, for Ale Barrels 11490>,

and for Ale Gallons 359; of which take these Examples.

What number of Beer Barrels and Gallons doth the last mentioned Tunn contain?

The three Coefficients for Beer Barrels divided by 10152 are:

The first = + .000007880220646 <
The second = — .0067375888 >
The third = + 1.8723404 <

The three Coefficients for Gallons being divided by 282 are:

The first = .0002837 >
The second = .2425532 >
The third = 67.4042553 >

The Coefficients being thus fitted, the Calculation is after this manner:

For Barrels.

+ .00000788 <
60

+ .00047280
— .00673758

— .00626478

— .00626478

—.00626478
60

—.37588680
+1.8723404

1.4964536
60

89.7872160

The Anſwer is 89 Barrels, 3 Firkins, and 1 Gallon, or 89 Barrels and 28 Gallons.

For Gallons.

+.0002837
60

+.0170220
—.2425532

—.2255312
60

—13.531872
+67.404255

53.872383
60

3232.342980

The Anſwer is 3232 Gallons, which divided by 36 quotes 89 Barrels 28 Gallons, as before.

Example.

36) 3232 (89 Bar.
352
---
28 Gall.

A New Way of

GAUGING

THE

Frustum of a *PYRAMID*

OR

CONICAL TUNN.

A New Way of GAUGING THE *Fruſtum* of a *Pyramid*, &c.

DEFINITION.

A *Pyramid* is a Solid Figure, contained under many Superficies, whereof one is the Baſe, and the reſt ariſe from the Baſe to the Vertex, and there meet in a Point.

The *Fruſtum* of a *Pyramid* is a Solid, cut with a Plane parallel to the Baſe, and the part cut off is alſo a Pyramid.

The *Fruſtum* of a *Cone*, may not improperly be termed the Fruſtum of a round Pyramid, (the Baſe being circular) nor do I think it an Hereſie to call a Cylinder a round Priſm.

The Fruſtum of a Pyramid, whoſe Baſes are in the form of any ordinate Polygon, being alike, and alike ſituate, and alſo if a Right Line

Line may be every where applied in the *Peripatasma* from Base to Base, moreover a Right Line being extended from the Center of one Base to the other, may be called the Axis.

Then if you put

S = *the whole Solidity.*

B = *a Side above.*

A = *a Side below.*

P = *the Perpendicular.*

d = *the common Addend at one Inch distance of the Perpendicular, and is thus made* $\frac{B-A}{P}d$, *that is, the difference between a Side above and a Side below, divided by the Perpendicular, quotes the increment, &c.*

G = *the Divisor.*

The Rule is:

$$G)AAp+Adpp+\tfrac{1}{3}ddppp(=S$$

Or, in other terms:

To the Square of the Side multiplied by the Perpendicular, add the Fact of one Side in the Increment multiplied by the Square of the Perpendicular, more $\frac{1}{3}$ of the q. of the Increment in the Cube of the Perpendicular, and the Aggregate divided by the Polygons respective Divisor, the Quote will be the Solidity.

And further it is to be well observed, if your Frustum of a *Pyramid* stand upon its greater Base, the Rule then is thus varied:

$$G):BBp-Bdpp+\tfrac{1}{3}ddppp(=S$$

That

That is to ſay:

From the Square of a Side at the Baſe multiplied by the Perpendicular, ſubduct the Rectangle of one of thoſe Sides in the Decrement multiplied by the Square of the Perpendicular, more one third of the Square of the Decrement in the Cube of the Perpendicular, and that Remainder divided by the Diviſor proper to the form of the Baſe, the Quote is equal to the Solidity.

Note alſo, that *p* may be put for a part of the Perpendicular, and the Anſwer will be the Content of that part required.

G) *or the Diviſors for theſe* 8 *Regular Polygons, and the Cone.*

For Cubick Inches.		*For Ale Gallons.*	
Trigon	2.30940	Trigon	651.2000
Tetragon		Tetragon	282.0000
Pentagon	.58123	Pentagon	157.2600
Hexagon	.38497	Hexagon	108.5400
Heptagon	.27513	Heptagon	77.5867
Octogon	.20710	Octogon	58.4022
Nonagon	.16176	Nonogon	45.6163
Decagon	.12997	Decagon	36.6515
Cone	1.27324	Cone	359.0500

If

If your Tunn be the Fruſtum of a Cone:

Let A *or* B *be the Diameter at the Baſe, and* d *the Increment or Decrement of any two Diameters between* A *and* B, *at one Inch diſtance of the Perpendicular, and the Diviſor as* per Table.

I ſhall only give you ſome Examples of the three firſt, and the Cones Fruſtum, which I think will be ſufficient to inform any ingenious Practitioner how to perform the reſt.

The Trigon.

Admit a Tunn be in the form of an equilateral Triangle, the Dimenſions being,
A = 126 *Inches, the length of a Side above,*
B = 108 *Inches, the length of a Side below,*
P = 60 *Inches, the Perpendicular,*
Q. *The Content in Ale Gallons?*

The Coefficients are found, according to the precedent directions, thus:

A — B
P = 60) 24.0 (.4 = *d* the Increment
.4
.16 = *dd*
.05333 firſt Coefficient.

102 = B
.4 = *d*

40.8 the ſecond Coefficient.

102
102

204
1020

10404 the third Coefficient.

Theſe three divided by the Diviſor for Ale Gallons, *viz.* 651.2, are as followeth:

The firſt Coefficient = .000082
The Perpendicular = 60

.004920
The ſecond Coefficient = .06265

.06757
60

4.05420
The third Coefficient = 15.9775

20.0317
60

The Anſwer = 1201.9020 Ale Gallons.

A Tunn

A Tunn of the ſame Dimenſions ſtanding upon its greater Baſe, the Coefficients are thus found:

B — A

P = 60) 24.0 (— .4

— .4

—

+ .16

.053333 firſt Coefficient.

126

— .4

—

— 50.4 the ſecond Coefficient.

126

126

756

252

126

15876 the third Coefficient.

Being divided by the ſame Diviſor with the former, they are:

+ .000082

— .077395

+ 24.380000

And

And are thus used:

$$
\begin{array}{r}
+.000082 \\
60 \\
\hline
+.004920 \\
-.07739 \\
\hline
-.07247 \\
60 \\
\hline
-4.34820 \\
+24.38 \\
\hline
20.0318 \\
60 \\
\hline
\end{array}
$$

The Answer as before = 1201.9080 Ale Gallons.

Now if each of these Tunns have 30 Inches of the Perpendicular wet, how much do they contain?

The First.

$$
\begin{array}{r}
+.000082 \\
30 \\
\hline
+.002460 \\
+.062565 \\
\hline
.065025
\end{array}
$$

+.065025
30
+1.950750
+15.9775
+17.92825
30

The Answer = 537.84750 Ale Gallons.

The Second.

+.00082
30
+.002460
—.07739
—.07493
30
—2.24790
+24.38
+22.1321
30

The Answer = 663.9630 Ale Gallons.

Proof.

663.9630
537.8475
1201.8105

The difference being less than a Pint,

The

The Tetragon or Square Pyramid.

There is a Tunn in the form of the Fruſtum of a Square Pyramid,
A = 144 *Inches, the length of a Side above,*
B = 108 *Inches, the length of a Side below,*
P = 60 *Inches, the Perpendicular,*
Q. *The Content in Gallons?*

The Coefficients being found by the former Rule and Example, *viz.*

P) A — B (= *d.*

$\frac{1}{3}$ of *d d* = the firſt Coefficient .12
d B = the ſecond Coefficient 64.8
B B = the third Coefficient 11664

Theſe three being divided by 282 the Cubick Inches in the Ale Gallon, are equal to

The firſt Coefficient = .00042553
60
.02553180
The ſecond Coefficient = .2298
.2553318
60
15.3199080

15.3199080
The third Coefficient = 41.3617
56.6816
60
The Anſwer = 3400.8960
Ale Gallons.

If the Tunn ſtand upon its greater Baſe, the Coefficients then are P) B — A (= — d, and the $\frac{1}{3}$ d d = the firſt, A d = the ſecond, and A A = the third, which divided by 282 the number of Cubick Inches in an Ale Gallon, they do appear to be = + .00042553
And if the Content be required 60
.02553180
— .306383
— .2808512
60
— 16.8510720
+ 73.532
+ 56.680928
60
The Anſwer = 3400.855680

If

If 40 Inches of the Perpendicular be wet in the first Tunn; and 20 in the latter, and it be demanded what they contain in Ale Gallons.

The first.	The second.
.00042553	+ .00042553
40	20
.01702120	+ .00851060
+ .2298	— .306383
+ .24682212	— .2978724
40	20
+ 9.8728480	— 5.9574480
+ 41.3615	+ 73.532
51.234548	+ 67.574552
40	20
2049.381920	1351.491040

Proof.

2049.38
1351.49
3400.87

The Pentagonal Pyramid.

A Tunn in the form of the Fruſtum of a Pyramid, whoſe Baſes are in the form of a Pentagon,
A = 144 *Inches, the length of each Side above,*
B = 108 *Inches, the length of each Side below,*
P = 60 *Inches, the Perpendicular,*
Q. *The Content in Ale Gallons?*

The three Coefficients found in the laſt Example, *viz.*

P) A — B(*d*

		For Ale Gall.
$\frac{1}{3}dd$ =	.12	= .0007632
B*d* =	64.8	= .412126
BB =	11664	= 74.18274

.0007632
60
.0457920
.412126
.457918
60
27.475080
74.18274
101.65782
60

The Anſwer = 6099.46920 Ale Gall.

Let

Let another Fruſtum of a Pyramid of the ſame Baſes and Altitude, ſtand upon its greater Baſe, and the Content in Ale Gallons be demanded.

The Coefficients ſo found and divided as before directed, are as followeth:

The firſt Coefficient = + .0007632
60
+ .0457920
The ſecond = — .5495
— .503708
60
— 30.222480
The third = + 131.88
101.65752
60
The Anſwer = 6099.45120

If 50 Inches of the Perpendicular in the firſt Tunn be wet, and 10 Inches in the laſt, what is the Content in Ale Gallons?

The first.	The last.
.0007632	+ .0007632
50	10
.03816 00	+ .0076320
.412126	— .5495
.450286	— .541868
50	10
22.514300	— 5.418680
74.182274	+ 131.88
96.69704	+ 126.46132
50	10
4834.85200	1264.61320

Proof.

4834.8520
1264.6132

6099.4652

A Tunn in the form of a Frustum of a Cone, the Bases being alike and alike situate, as in the precedent Examples, the Dimensions being,
A = 144 *Inches, the diameter above,*
B = 108 *Inches, the diameter below,*
P = 60 *Inches, the Perpendicular,*
Q. *The Content in Ale Gallons?*

P) A — B (= d.

.6 = d

.6 = *d*
.6

.36 = *dd*

.12 = the first Coefficient.

108 = B
.6

64.8 = the second Coefficient.

108
108

864
1080

11664 = BB, third Coefficient.

These three divided severally by the Divisor proper to a Cone, as in the Table mentioned, *viz.* 359.05 they quote:

The first = .000334
60

.020052
The second = .180476

.200528
60

12.031680

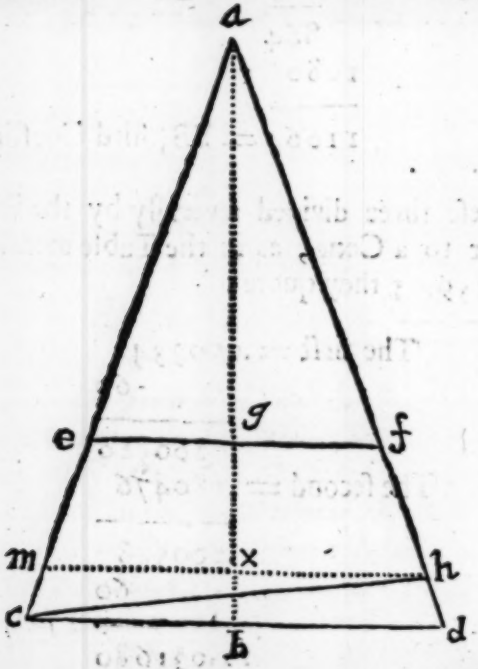
12.031

12.03168
The third = 32.48572

44.51740
60

The Answer = 2671.0440 Ale Gall.

And that the young Gauger may not be obliged to Dray-men to repleat the horizon with liquor, of such Tunns whose Bases are not posited parallel thereto, (as indeed most are not being made with a Drip or Fall) let him take this Example, *a b c d e f g h m x*, a Cone or Pyramid.



Having

Having the length of each Line in this Diagram, and the Content of the whole Cone or Pyramid in Cubick Inches, Gallons, or Barrels, *&c.* the Quantity of the Hoof *h c b d* is found by this Analogy:

As the Cube of the Line a c,
to the whole Solidity:
So is the Cube of a Geometrical Mean between a c *and* a h,
to the Content of the Cone or Pyramid cut off:

Which ſubducted from the whole, the remainder is the Content of the Hoof.

Some of the Lines being given, the reſt are to be found.

Example.

There is a Tunn taken as the Fruſtum of a Cone,
c d = 144 *Inches, the greater Baſe,*
e f = 108 *Inches, the leſſer Baſe,*
g b = 60 *Inches, the depth.*

Admitting the Baſe were raiſed 3 Inches, as the Line *c h*, it is then neceſſary to take another Diameter between *c h* and *e f* to find *c d*.

To find a b *the Cones Axe.*

As 18, *the ſemi-diff. of Diam.*	*co. ar.*	8,744728
to 72, *the ſemi-diam. at the Baſe:*		1,857332
So is 60, *the Tuns depth,*		1,778151
to 240, *the Cones Axe.*		2,380211
q. of *a b* 240	5,760422	= 57600
q. of *c b* 72	3,714664	5184
Log. of the Sum of their q.	4,797848	62784

The

The Logarithm of *a c* 256.567	2,398924
The Logarithm of *a h* 247.567	2,393692
	4,792616
A Geometrical Mean	2,396308

To find the Content of the whole Cone.

The Square of 144	4,316724
$\frac{1}{3}$ of *a b* = 80	1,903090
559 *&c.* *complement arithm.*	7,444842
Content in Ale Gallons 4620 *fere*	3,664656

The Line a c, *the Line* a h, *and the Content being known, to find the Content of the Fall* c b d h.

As the Cube of a c,	*co. ar.*	2,803228
to the whole Content:		3,664656
So is the Cube of the Mean,		7,188924
to the Content of the Cone cut off.		3,656808

4537.4
4620

82.6 the Content of the Fall.

Or thus:

As the Cube of a c,	*co. ar.*	2,803228
to the whole Cones Solidity:		3,664656
So is the Cube of a h,		7,181076
to the leſſer Cones Solidity.		3,648960

4456 *fere.*

The whole Cone = 4620

The Fruſtum *m x h c b d* = 164

The being $\frac{1}{2}$ the Fall or Hoof = 82

Some Practical

RULES & EXAMPLES

FOR

CASK-GAUGING.

5

Some Practical

RULES & EXAMPLES FOR *CASK-GAUGING.*

THE Corner-ſtone in the whole Fabrick of Cask-Gauging, as full, was long ſince laid by Mr. *Oughtred*, taking a Cask to be the Fruſtum of a Spheroid, under which capacity they are generally received, though indeed there have been, and daily are found ſome Cask differing in form, and really are more Parabolical than Spheroidal, I ſhall therefore lay down a plain Method for the performance of the Work (*viz.* finding their Content) under theſe four Conſiderations:

As { Spheroidal, / The Fruſtum of a Parabolical Spindle, / The Fruſtum of a Parabolical Conoid, / The Fruſtums of two Cones abutting upon one common Baſe.

Theſe

Theſe ſeverally, with and without a Table of Area's of Circles.

And foraſmuch as the Dimenſions muſt be the firſt thing known, before the Content can be found, I ſhall therefore ſhew the young Tyro, how by ſome of the Dimenſions to find the reſt, if any obſtruction prohibit the taking of all.

The Boung-diameter, and Head-diameter, and Diagonal, to find the Casks length.

Firſt ſubduct the ſemi-difference of Diameters from the Boung-diameter, and Square the Remainder, which Square ſubduct from the Square of the Diagonal, and the Remainder is the Square of the Casks ſemi-length.

Example.

Let B D be the Boung-diameter = 29 Inches,
H E be the Head-diameter = 23 Inches,
B E be the Diagonal = 35.3836 Inches,
S D the ſemi-difference = 3 Inches:
Q. the Length = L T?

The Square of B E = 1252
Square of B D — S D = 676

Square of ſemi-length = 576 √ 24
24
48 = L T.

This very Queſt. was intended by Mr. *Smith*, p. 176. but through a Miſtake it was left out.

The

The Boung-diameter, Diagonal, and Length, to find the Head-diameter.

The Rule.

From the quadrupled Square of the Diagonal ſubduct the Square of the Length, (which done) the Square Root of the Remainder is equal to the Sum of the Boung-diameter and one Head-diameter.

Example.

The Square of Diagonal = 5008
Square of the Length = 2304

Remainder = 2704 √ = 52
Subduct the Boung-diameter = 29

Head-diameter = 23

The Head-diameter, Boung-diameter, and the Length, to find the Diagonal.

The Rule.

To the Square of the Semi-length add the Square of the Boung-diameter, leſs the Semi-difference of Diameters, and the Square Root of their Sum is equal to the Diagonal.

Example.

Square of Semi-length = 576
Square of 26 = 676

Square of Diagonal = 1252 √ 35.3836

A Cask taken as the Frustum of a Spheroid, cut with two Plane Parallels, each Plane bisecting the Axis at right Angles,
B *the Boung-diameter* = 29 *Inches*;
H E *the Head-diameter* = 23 *Inches*,
L T *the Length* = 48 *Inches*:
Q. *The Content in Wine Gallons?*

The Rule.

To the doubled Square of the Boung-diameter add the Square of the Head-diameter, their Aggregate multiply by the Length, and to the Product add the tenth part of it self, more one third of that tenth part, and from the Sum cut off as many places toward the right hand as were in the Multiplicand.

Example.

The doubled Square of 29 = 1682
The Square of 23 = 529

The Aggregate = 2211

The Length =	2211 48
	17688 8844
The Product =	106128
— Tenth =	106128
The $\frac{1}{30}$ part, or $\frac{1}{3}$ of $\frac{1}{10}$ =	35376
The Answer =	120.2784 Wine Gallons.

Another way.

The q. of the Bung-diameter =	841
The q. of the Head-diameter =	529
The Sum of their Squares =	1370
The Semi-sum =	685
The Semi-diff. of Squares =	156
Their Aggregate =	2211
The Length =	48
	16788 8844
The Product =	106128
The tenth part =	106128
The $\frac{1}{30}$ part or $\frac{1}{3}$ of $\frac{1}{10}$ =	35376
The Answer in Wine Gall.	120.2784

The same Cask being taken as the Frustum of a Parabolical Spindle, the Content may be thus found.

q. of the Boung-diameter	= 841
q. of the Head-diameter	= 529
The Aggregate	= 1370
The Semi-sum	= 685
The tenth part of the Diff.	= 312
	20862
The Length	= 48
	166896
	83448
The Product	= 1001376
Tenth of the Product	= 1001376
$\frac{1}{3}$ of $\frac{1}{10}$	= 333792
The Answer in Wine Gall.	113.48928

If taken as the Frustum of a Parabolical Conoid, cut as before mentioned, the Content may be found as in this

Example.

q. of the Boung-diameter	= 841
q. of the Head-diameter	= 529
The Sum	= 1370

1370

	1370
Semi-ſum =	685
	2055
The Length =	48
	16440
	8220
The Product =	98640
Tenth part of the Product =	98640
$\frac{1}{30}$ part, or $\frac{1}{3}$ of $\frac{1}{10}$ =	32880
The Anſwer in Wine Gall.	111.7920

If a Cask of the ſame Dimenſions be taken as the middle Fruſtum of two Cones abutting upon one common Baſe, cut with two Planes parallel, and each biſecting the Axis at Right Angles, the Content in Wine Gallons may be found as in this

Example.

q. of the Bung-diameter =	841
q. of the Head-diameter =	529
The Sum =	1370
The Semi-ſum =	685
	2055
Semi-q. of diff. of Diam. =	18
	2037

2037
48

16296
8148

97776
97776
32592

The Anſwer in Wine Gall. 110.8128

For finding the Capacity of theſe, or any other Veſſels, it is convenient to have always in readineſs a Table of Area's of Circles in Wine and Ale Gallons: I think it unneceſſary to ſwell this intended ſmall Volume with them, there being two lately Printed, exactly Calculated to every tenth part and quarter of an Inch, and alſo a Table of Area's of Segments of a Circle, by my good Friend Mr. *John Smith*, in his Book of *Gauging*, to whom in gratitude I am obliged to render my hearty acknowledgment for many favours and kind aſſiſtances in theſe Studies; yet that you may be able to find any Area of a Circle upon demand, in Wine or Ale Gallons, without a Table, take this

Rule.

Divide the q. of the Diameter by 294.1 for Wine, and by 359.05 for Ale Gallons, and the Quotient exhibits the Area. Or, ſaith Mr. *Smith*, Multiply the q. of the Diameter by .0034 for

Wine

Wine, and by .0027851 for Ale Gallons, and the Product exhibits the Area in such Gallons.

As in these Examples.

The Diameter of a Circle = 21.7 : Q. *The Circles Area in Wine Gallons?*

```
        21.7
        21.7                    470.89
        ----                     .0034>
        1519                    ------
        217                     188356
        434                     141267
        ----                    ------
294<)470.89(1.601              1.601026
     1768
     ...490
```

The Diameter of a Circle = 26.8 : Q. *The Area in Ale Gallons?*

```
        26.8                    |718.24
        26.8                .00 |27851
        ----                ---- |------
        2144                  1 |
       1608                  35 |
       536                  574 |
       ----                5027 |
359.05)718.24(2.00        14365 |
       71810               ----- |
       -----               2.0002 |
         140
```

For finding the Capacity of a Cask, taken as Spheroidal, by a Table of Area's of Circles in Gallons.

Example.

A Casks Boung-diameter = 29 *Inches, Head-diameter* = 22, *and the Length* = 48 *Inches:*
Q. *The Content in Wine Gallons?*

⅔ of the Area of the Boung ⊙ = .9531
⅓ of the Area of the Head ⊙ = .5996

Their Sum = 1.5527
Semi-sum = .7763
Semi ∽ = .1768

Area of Mean Circle = 2.5058
The Length = 48

200464
100232

The Answer in Wine Gall. 120.2784

Another way.

⅔ of the Area of Boung ⊙ = 1.9062
⅓ of the Area of Head ⊙ = .5996

The Area of Mean ⊙ = 2.5058
The Length = 48

200464
100232

The Answer = 120.2784

That is, 120 Gallons, 1 Quart, and ¼ of a Pint, *ferè*.

To find the ſolid Content of a Cask, when taken as the middle Fruſtum of a Parabolical Spindle, &c.

The Dimenſions as before.

⅔ of the Area of Boung ⊙ =	.9531
⅓ of the Area of the Head ⊙ =	.5996
Their Sum =	1.5527
Semi-ſum =	.7763
Tenth of the Difference =	.03535
Area of Mean ⊙ =	2.36435
The Length =	48
	1891480
	945740
The Anſwer in Wine Gall.	113.48880

That is, 113 Gallons, and almoſt 2 Quarts,

And as the Fruſtum of a Parabolical Conoid, the Capacity is thus found:

⅔ of the Area of the Boung ⊙ =	.9531
⅓ of the Area of the Head ⊙ =	.5996
Their Sum =	1.5527
Semi-ſum =	.7763
Area of the Mean ⊙ =	2.3290
The Length =	48
	18632
	9316
The Anſwer in Wine Gall.	111.792

If a Cask be taken as the middle Fruſtum of two Cones, abutting upon one common Baſe, &c.

The Dimenſions as before.

$\frac{8}{31}$ of the Area of the Boung ⊙ =	.9531
$\frac{4}{31}$ of the Area of the Head ⊙ =	.5996
Their Sum =	1.5527
The Semi-ſum =	.7763
	2.3290
$\frac{2}{6}$ of Area of 6 the ∽ of Diam.	.0204
The Area of Mean ⊙ =	2.3086
The Length =	48
	184688
	92344
The Anſwer in Wine Gall.	110.8128

The Ullage, or Wants in a Cask, may be found under theſe two Conſiderations:

1. A Cask ſtanding on the Head, with the Diameters parallel to the Horizon.

2. A Cask lying with the Axe parallel to the Horizon.

Prop. I.

In a Cask ſtanding on the Head, with the Diameters parallel to the Horizon, ſome Liquor remaining, to find how many Wine Gallons it is.

Here are these five things necessary to be known:

1. The Diameter at the Boung.
2. The Diameter at the Head.
3. The Length of the Cask.
4. The Depth of the Liquor.
5. The Diameter of the Liquors superficies.

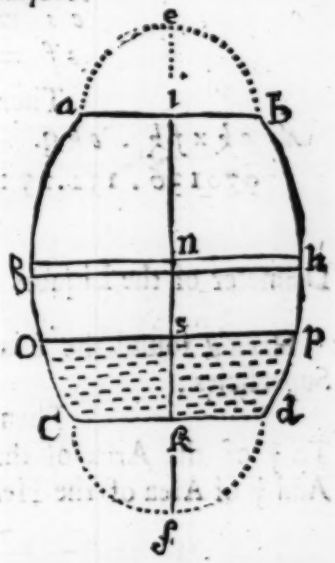
Example.

Let $g\,h$ be = 29

$a\,b$ & $c\,d$ = 23

$i\,k$ . . = 48

$s\,k$ . . = 11,6



The Diameter $o\,p$ is thus found, first find the Axis of the whole Spheroid $e\,f$, thus; from the Square of half the Boung-diameter $(n\,h)$ subduct the Square of half the Diameter at the Head, and extract the Square Root of the Remainder: Then by the Rule of Proportion, say, *As that* q √, *is to* n h, *the Semi-boung-diameter: So is* n i, *the Casks Semi-length, to* e n *half the Axis sought,* q. *n h*

q. nh = 210.25
q. ai = 132.25

78.00 √ = 8.8311 >

As 8.8318 > . 14.5 :: 24 . 39.4

Then is fe = 78.8
ek = 63.4
fk = 15.4
es = 51.8
sf = 57

Then,

As $ek \times fk$. ekq. :: $es \times sf$. soq.
976136 . 132.25 :: 1398.6 . 13.7
15.7 *sp*

Diameter of the Liquors Superficies 27.4

Having found the Diameter of the Liquors Superficies:

Then,

To $\frac{2}{3}$ of the Area of that Circle = 1.70173
Add $\frac{1}{3}$ of Area of the Head Circle = .59953

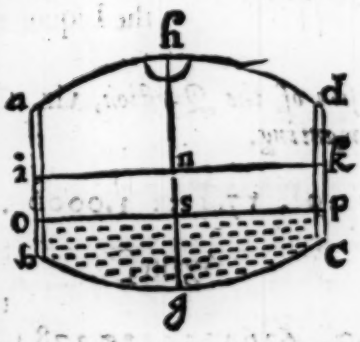
2.30126
The Depth of Liquor = 11.6

1380756
230126
230126

The Answer in Wine Gallons = 26.694616
Which subducted from the whole Content, leaves the Ullage or Wants. Prop.

Prop. II.

A Cask lying with its Axe parallel to the Horizon, and having some Liquor remaining in it, to find the Content of the said Liquor in Gallons.



Let the Dimensions be as before.

In this Proposition there is five Requisites attending:

h g the Diameter at the Boung = 29.
a b the Diameter at the Head = 23.
i k the Length = 48.
s g the Depth of Liquor = 11.6.
And the Content of the whole Cask in Gallons.

Then by the help of a Table of Area's of Segments of a Circle, whose Area is Unity, and the Radius divided in the Ratio of 1,0000 Parts, say by the Rule of Proportion:

	h g	*s g*	Radius	
As	29	11.6 ::	1,0000	.4 versed Sine or Arrow of Segment.

Then

Then seeking in the Table you will find .4000, and right against it under the Title *Area* you will find .37353. Then say:

whole Content

1.0000 . .37353 :: 120.2784 . 44.9276

the Liquor remaining.

The Inversion of the Question, viz. To find the Liquor wanting.

As 29 . 17.4 :: 1.0000 . .6

Again,

the Ullage.

As 1.0000 . .62647 :: 120.2784 . 75.3509

The Liquor remaining = 44.9276

Which together make 120.2785

the Casks whole Capacity.

FINIS.

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ERRATA.

PAg. 3. l. 4. r. in the third. P. 5. l. 22. r. 20:13. P. 7. l. 17. r. 42:3:08:15; l. 19. r. 33:0:05:04. P. 9. l. 1. r. borrow of the. P. 13. l. 14. r. 5 s. the bushel. P 16. l. 13. r. 22 times. P. 19. l. 1. r. 5 from d. P. 31. l. 19. dele always. P. 39. l. 22. r. in the decimal Fractions of both Factors. P. 50. l. 15. r. solid measure. P. 51. l. 15. r. 272.25. P. 52. l. 15. r. .0041667. P. 67. l. 14. dele as before. P. 82. l. 14. r. $\frac{1}{4}$ d. P. 188. l. ult. r. $\frac{1}{2}$ being.

THe *Rules herein mentioned, and other* Mathematical Arts, *are taught by the Author*, viz. Arithmetick, Vulgar, Decimal, *and* Logarithmetical; *the* Doctrine of Triangles, Plain *and* Spherical; *the* Use of the Globes, Quadrant, Sector, *and other* Mathematical Instruments; Fair Writing, *and* Merchants Accompts, *by way of* Debitor *and* Creditor; *also the Art of* Short Writing.

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